Attributing human and bioclimate impacts to carbon loss in tropical forest

“However, there is little detail … on how the goal will be met or … how it will be monitored”

UK Centre for Ecology & Hydrology

6th Nov 2021

MARIO TAMA/GETTY IMAGES

A deforested section of the Brazilian Amazon in 2017

COP26

An end to deforestation?

The first major pledge from the COP26 climate summit is a plan to save the world's trees by 2030, reports **Adam Vaughan**

NATIONS representing 85 per cent of the world's forests have pledged to end deforestation by 2030 in a renewed effort to stem the carbon emissions released by trees being cleared, nearly all for agriculture.

The Glasgow Leaders' Declaration on Forests and Land Use, issued on 2 November by more than 100 countries plus the European Union at the COP26 climate summit in the UK, comes alongside £14 billion of new funding to combat forest loss over five years. The money is being provided by 12 nations, including the UK, plus private organisations, including the Bezos Earth Fund.

Experts welcomed the renewed focus on forests and the new funding, but warned that the way deforestation is tackled will be key to whether the 2030 goal is met.

"We cannot reach climate goals if we don't keep trees standing," says Frances Seymour at the World Resources Institute, a think tank in Washington DC. She says it is good that trees are one of the UK government's four priorities at COP26, along with climate finance, ending coal use and phasing out cars that use fossil fuels.

The 2030 goal is identical to one made seven years ago by a smaller group of countries, known as the New York Declaration on Forests. They also set an interim goal of halving deforestation by 2020, a target missed by a wide margin.

But a key difference is the new plan is signed by several countries that were missing last time, including those with the greatest deforestation rates, such as Brazil. "Having all the main players on it is significant, that is a big step," says Stephanie Roe at the University of Virginia.

While £14 billion looks big, it still isn't on a par with what will be needed to meet the deforestation targets of the 2015 Paris climate deal. Meeting those would mean spending an estimated $45 billion to $460 billion a year to protect, restore and enhance forests. Nonetheless, Roe says the funding is a "very welcome and critically needed addition".

So, is it realistic that deforestation could be halted by 2030? "Yes, I think it is feasible. It is difficult, but it is feasible," says Seymour. "The main constraint in most places is political will."

She says there is precedent for action, citing the example of Brazil in the early 2000s, which successfully used policies to slow deforestation rates at the time. Other reasons for hope include a growing awareness among governments that trees aren't just important for locking away carbon, but also for protecting against the impacts of extreme weather, such as preventing soil erosion. Modern satellite monitoring of forest loss helps too, Seymour adds.

However, there is little detail in the new declaration on how the goal will be met – such as paying countries for preventing projected clearances – or how progress will be monitored. The goal also isn't binding. Seymour says that the new funding won't help unless simultaneous efforts are made to cut off the agricultural subsidies that drive much logging.

We need to know that measures will be used to stop forest loss, says Constance McDermott at the University of Oxford. "It is not possible to comment on these very bold and flashy promises without seeing, in full view and detail, how they will be operationalised," she says. It is key that efforts benefit local and Indigenous communities as well as biodiversity, rather than consolidating money and power in the hands of a few states and corporations, she says. ▮

The latest news from COP26
Online every weekday
newscientist.com/COP26news

REDD+ finance buffer against fires

- Countries are paid to retain forest carbon, with payments approuching $1billion.
- A “buffer” is set aside should fire damage carbon stocks.

1. If carbon is lost to a **fire event**, is it **meteorological** or **direct human (mis-)management**

1. If carbon is lost to a **fire event**, is it **meteorological** or **direct human (mis-)management**.

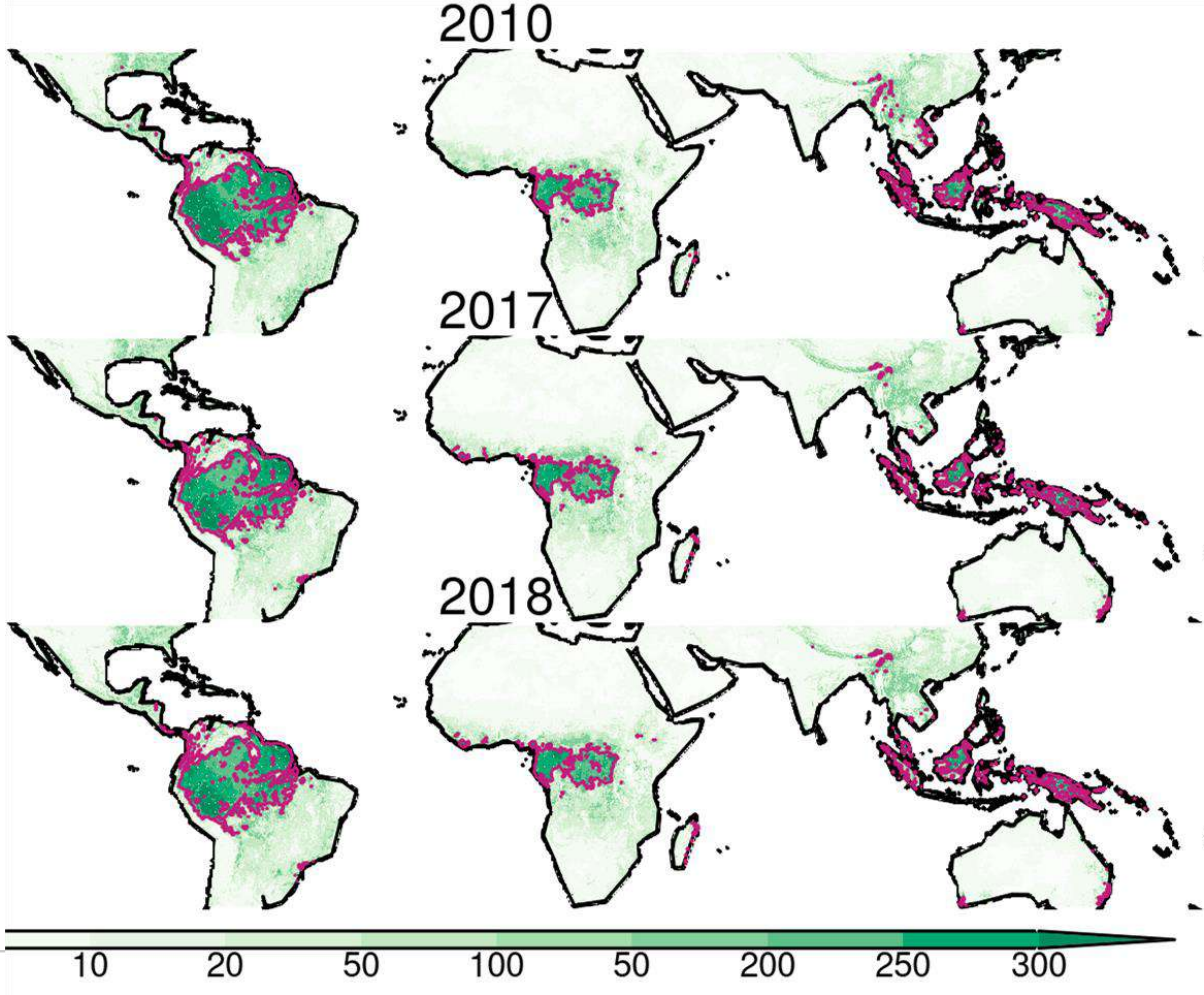
2. How big should this buffer be?
3. Can we determine where forest are vulnerable to future changes in fire?

2019 fires in the Amazon rainforest by ESAs Luca Parmitano on the ISS

Slash and burn agriculture in the Amazon, Matt Zimmerman

Tools/data

- Observations of above ground carbon for specific points in time
- Observations of annual burnt area, and semi-observations of fire carbon emissions
- Modelled above and soil carbon, fire and fire carbon emissions

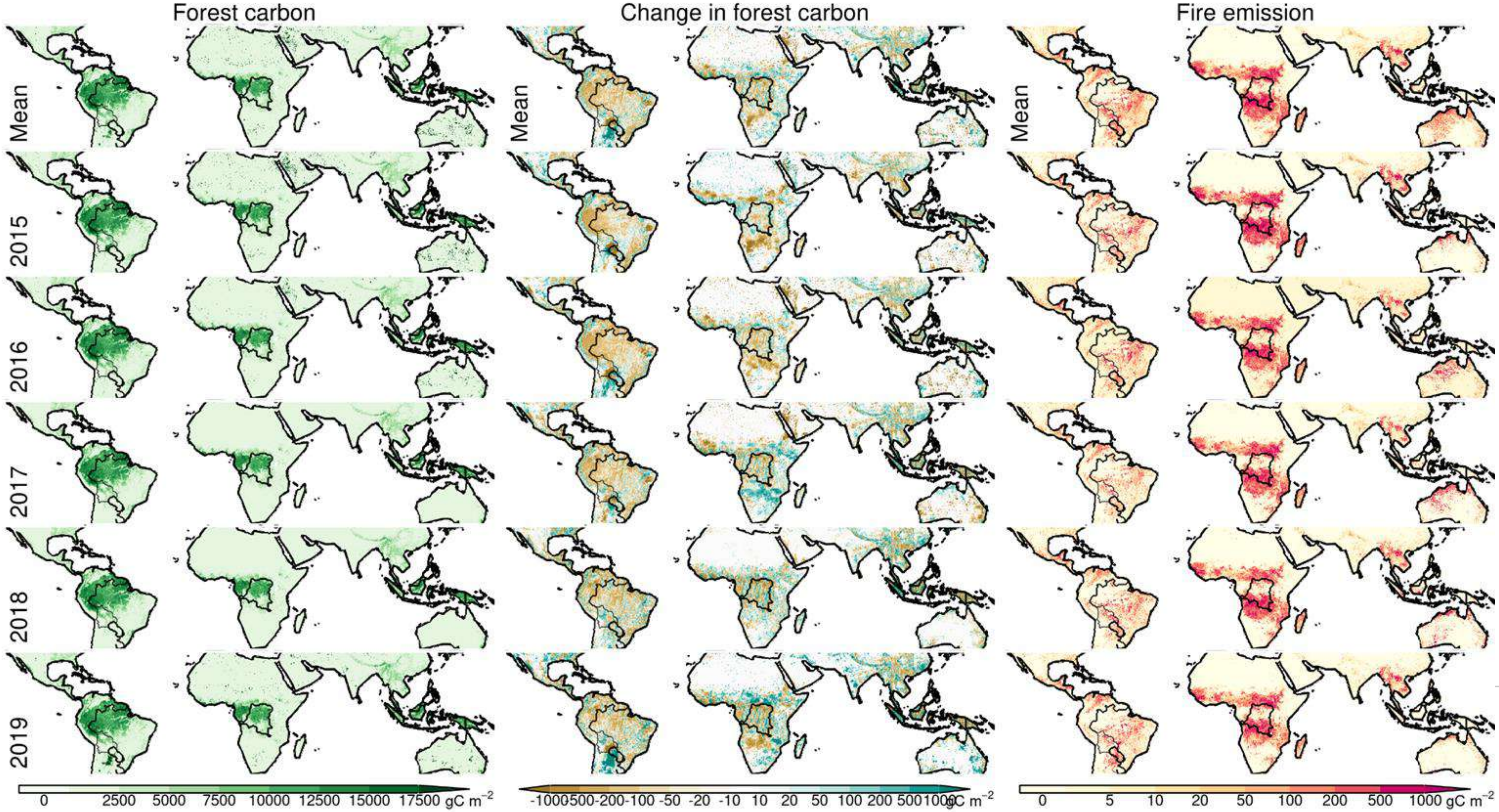


UK Centre for Ecology & Hydrology

Simple bias correction.

Per grid cell:

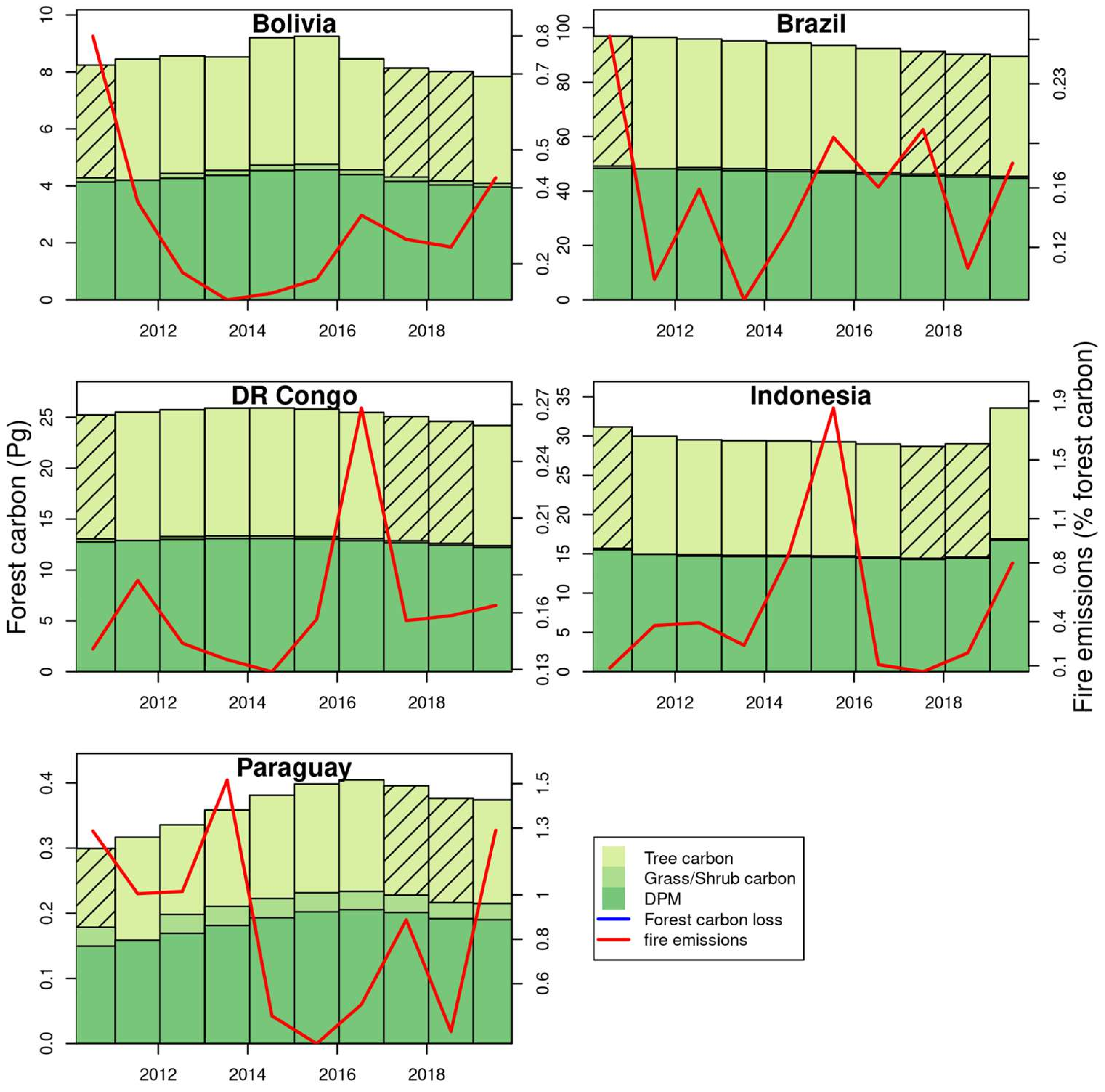
1. Bias correct:
   a. JULES fire emissions to GFAS observations and apply change to modelled AGC
   b. JULES above ground carbon pools to CCI observations in 2010, 2018, 2019
2. Apply a spline interpolation to years in between observations.



UK Centre fo
Ecology & Hy

Historic carbon losses

Combining satellite observations and JULES-ES simulations to estimate forest carbon (green) and the % lost to fire each year (red)

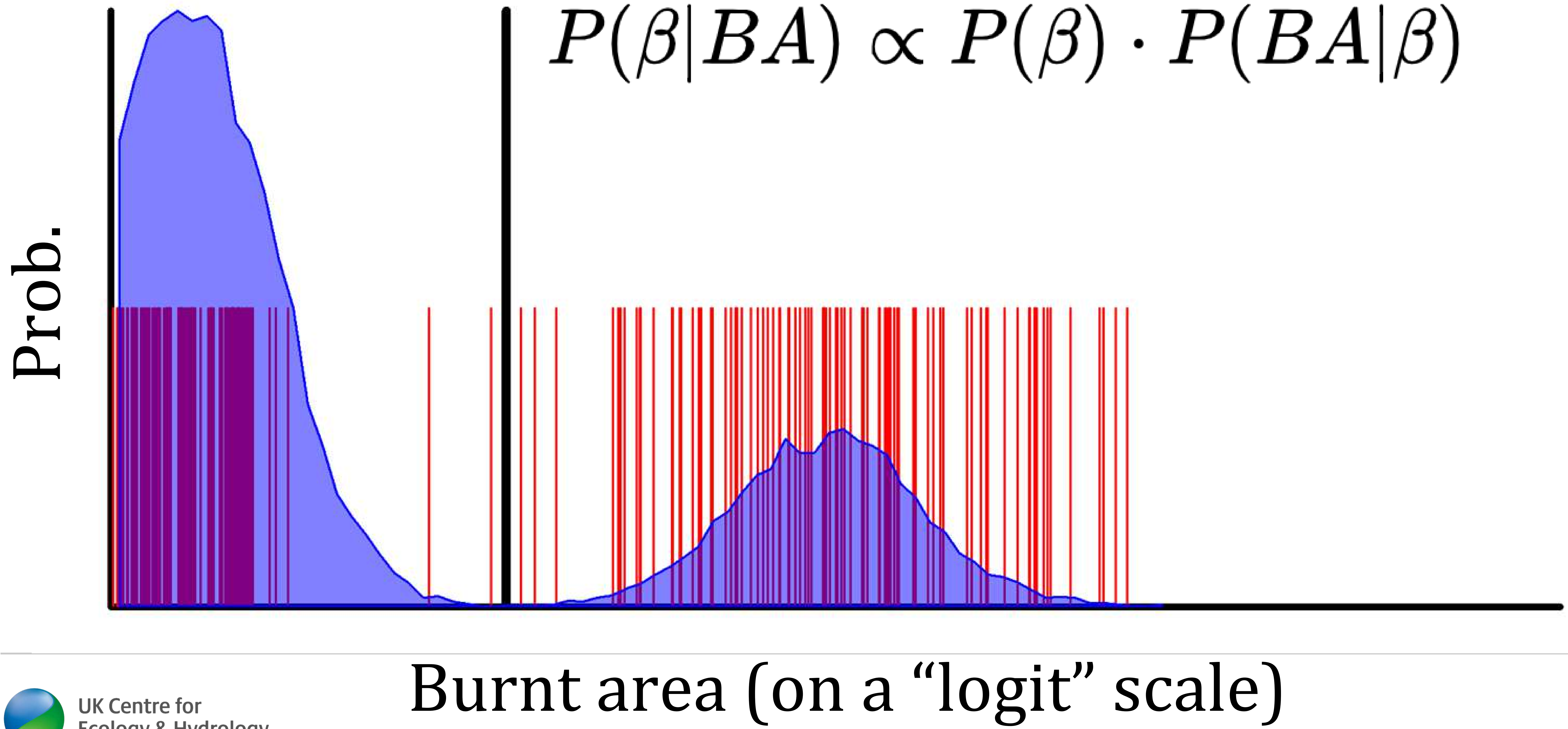


Sullivan et al (in press) Spreading like Wildfire: The Rising Threat of Extraordinary Landscape Fires, UNEP RRA

Problems still

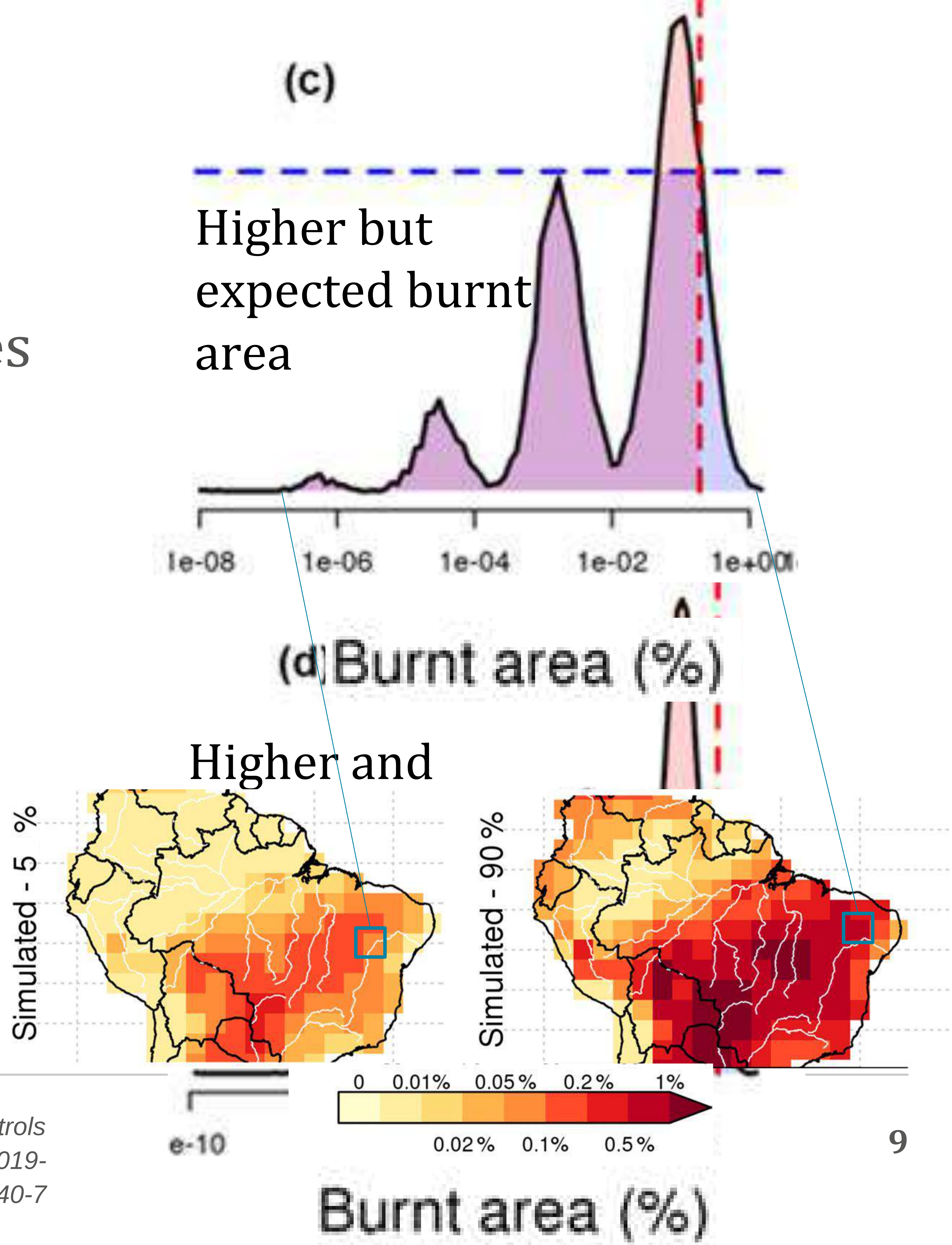
1. How much fire was meteorological or human?
2. If not fire, how much is active deforestation, mismanagement or meteorological?
3. What is the unbalanced
4. What is the long term change in storage after these events?
5. Assumes observations are truth
6. How do we go beyond last ABC observation?
7. How confident are we in our results?

Fire under "same" bioclimatic conditions (0.4 < fuel < 0.6; 0.8 < flammability)



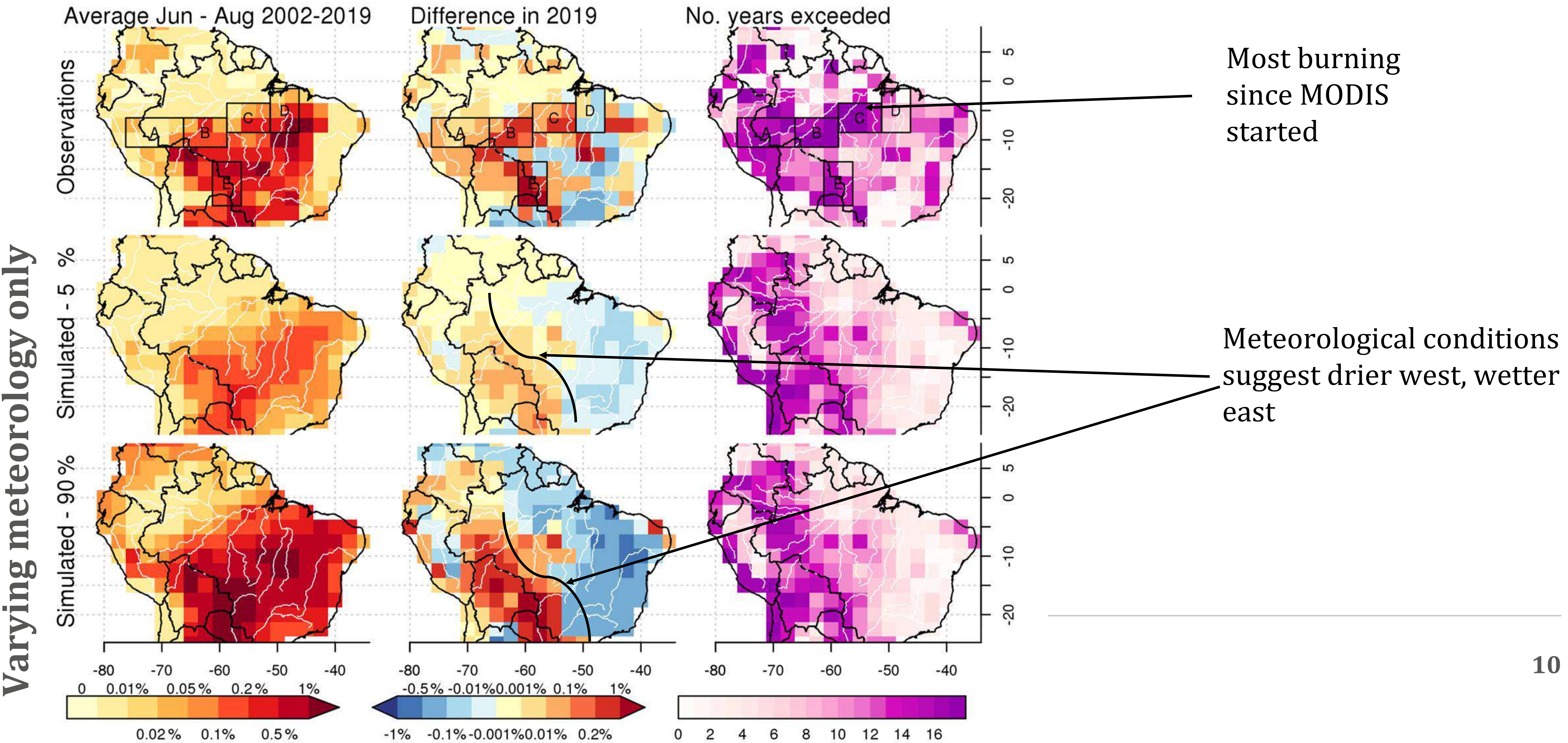
Attributing causes of fires

Uncertainty in modelling fire/human fires makes traditional attribution hard

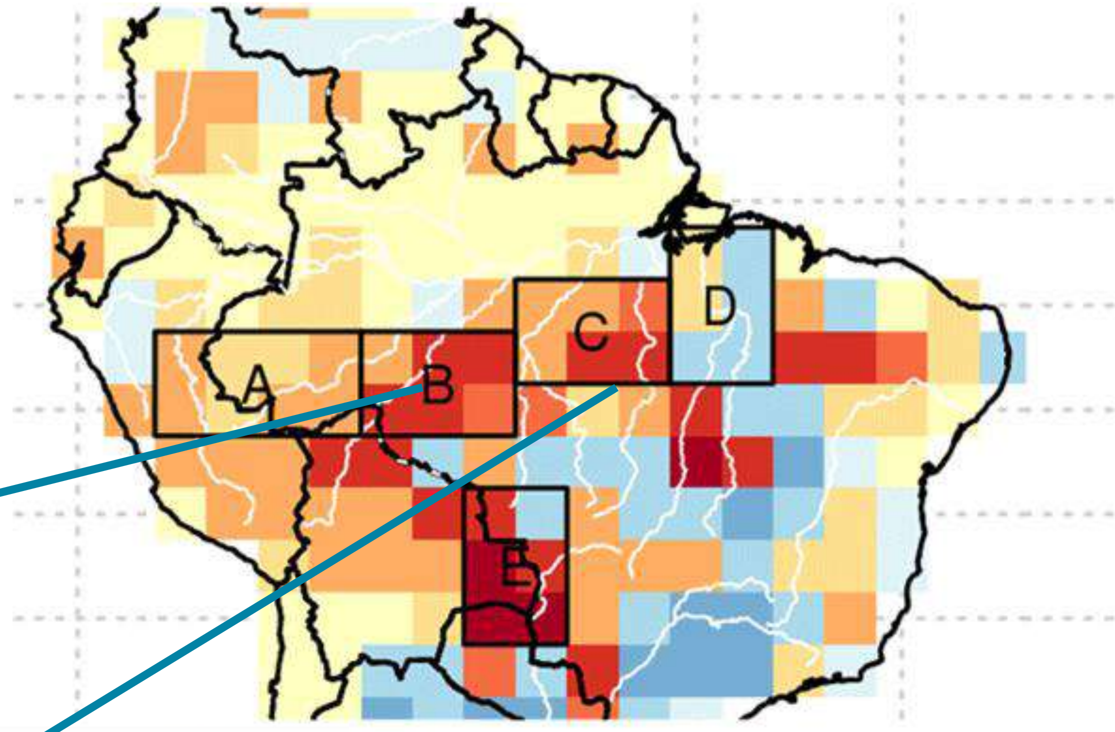


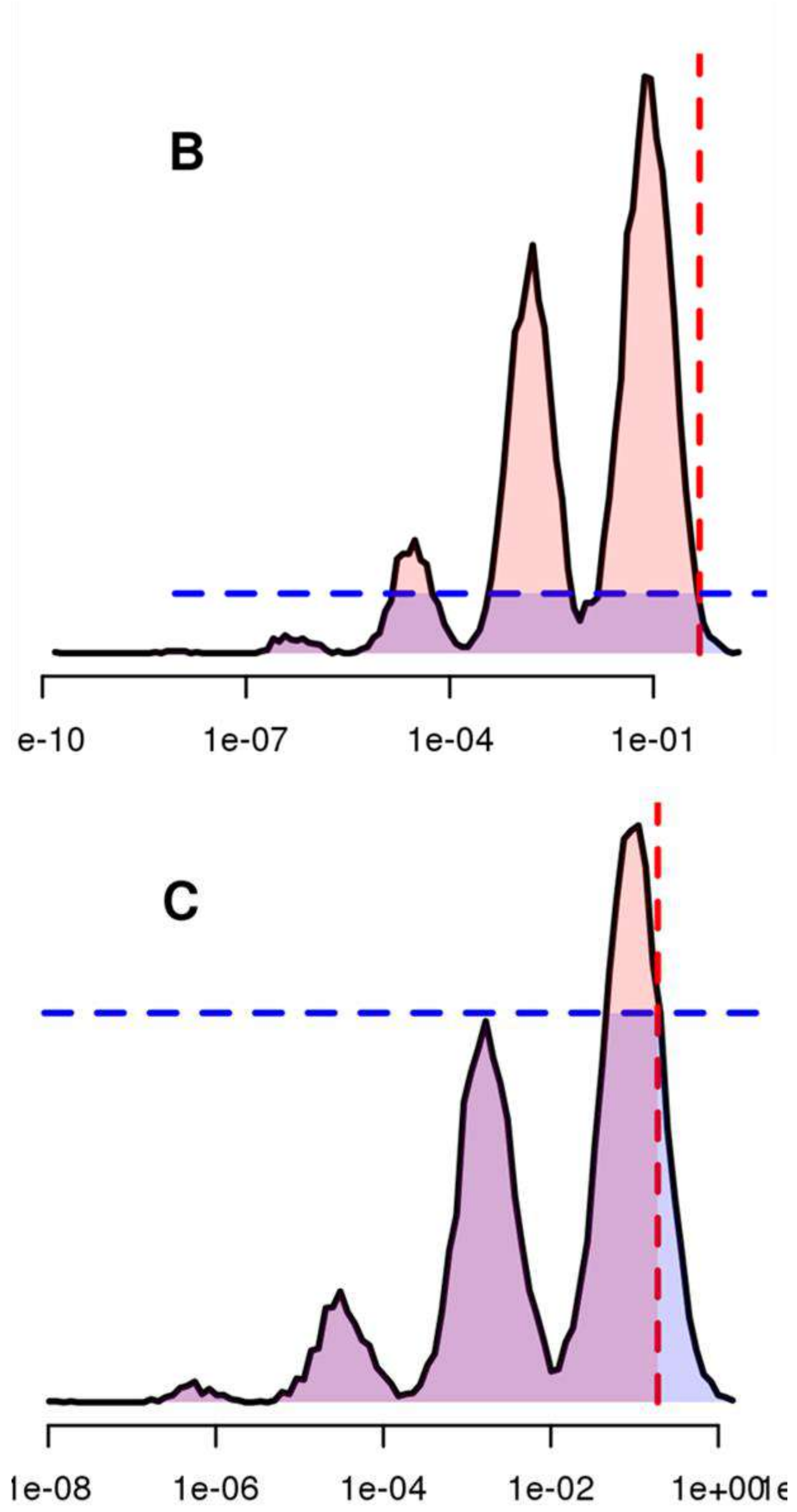
Kelley et al (2019) How contemporary bioclimatic and human controls change global fire regimes. Nat. Clim. Chang. doi:10.1038/s41558-019-0540-7

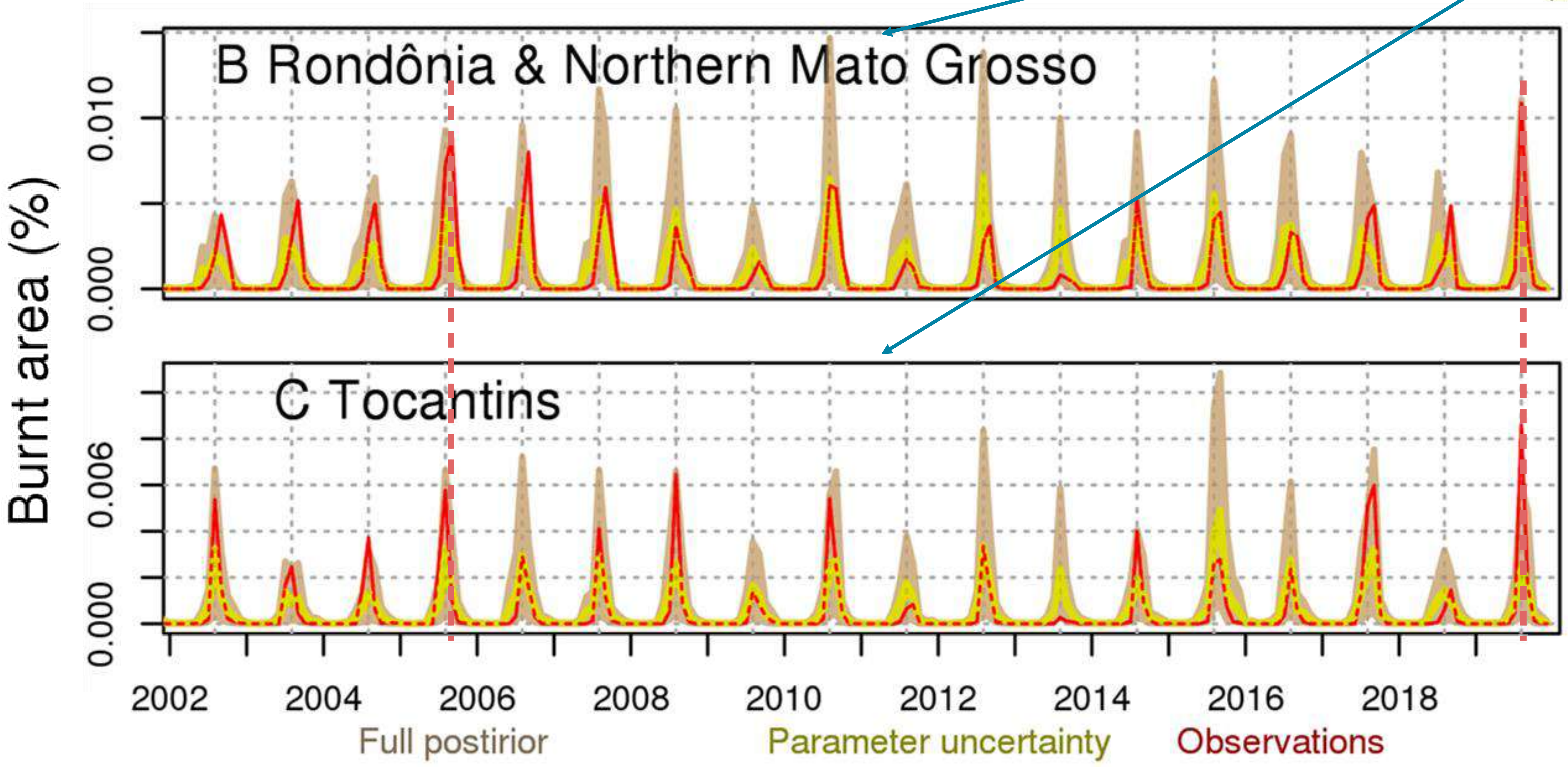
Example: 2019 Amazon burnt area

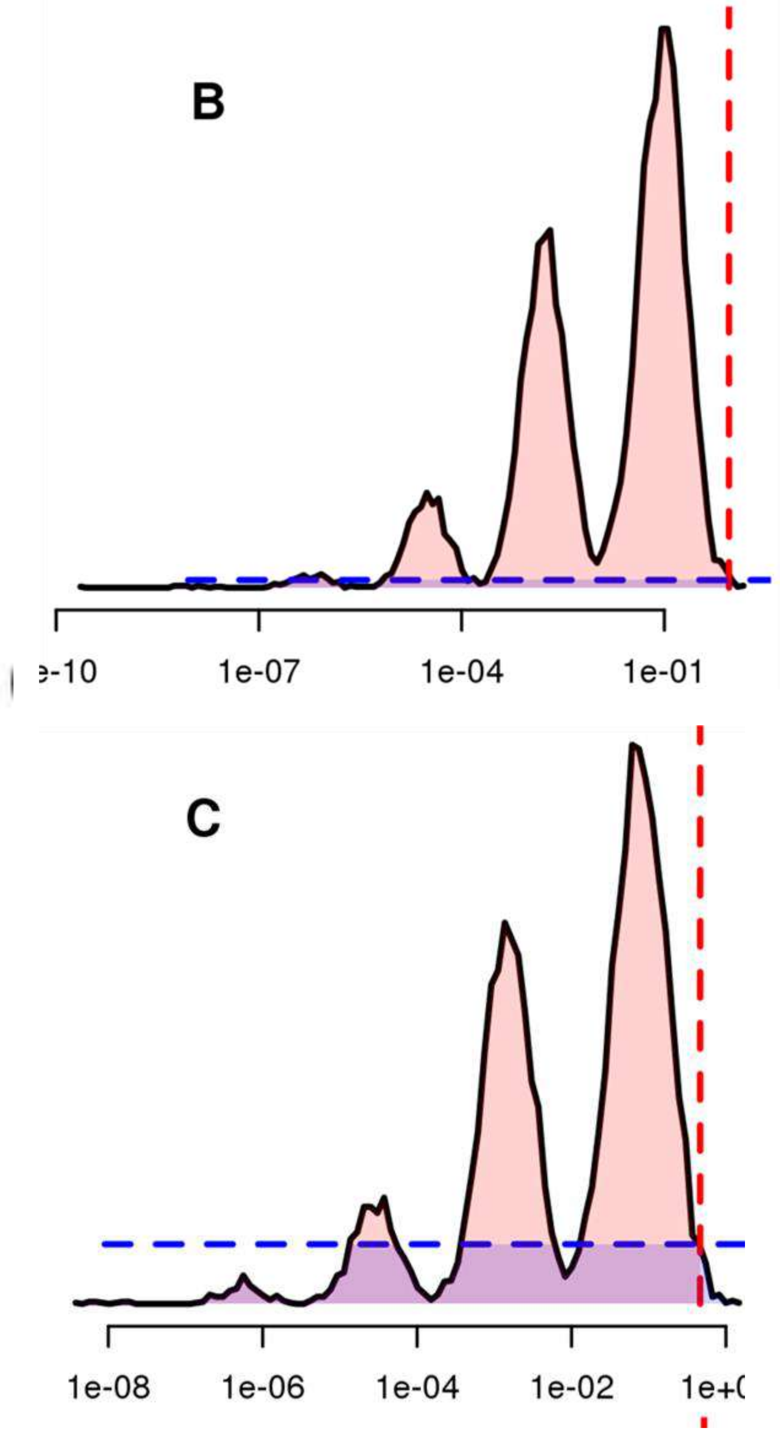


Example: 2019 Amazon burnt area









Kelley et al (2021) Technical note: Low meteorological influence found in 2019 Amazonia fires, doi:0.5194/bg-18-787-2021,

UK Centre for Ecology & Hydrology

It is unlikely (6-7%) that weather conditions caused 2019 Amazonia fires.

What next for REDD+ buffer

- (de-)Attribute fire emissions and carbon loss as well as burnt area
- Run for all participating countries
- Use to explatolate medium term carbon risk (i.e buffer size)
- Determine long term carbon risk (i.e climate change vulnerability)

Douglas Kelley, Chantelle Burton.
Rob Parker, Dong Ning, Joshua Chew,
Camilla, Mathison, Tiina Kurvits,
Andrew Sullivan, Gabriel Labbate,
Elaine Baker, Chris Huntingford,
Rhys Whitley, Megan Brown.


1932

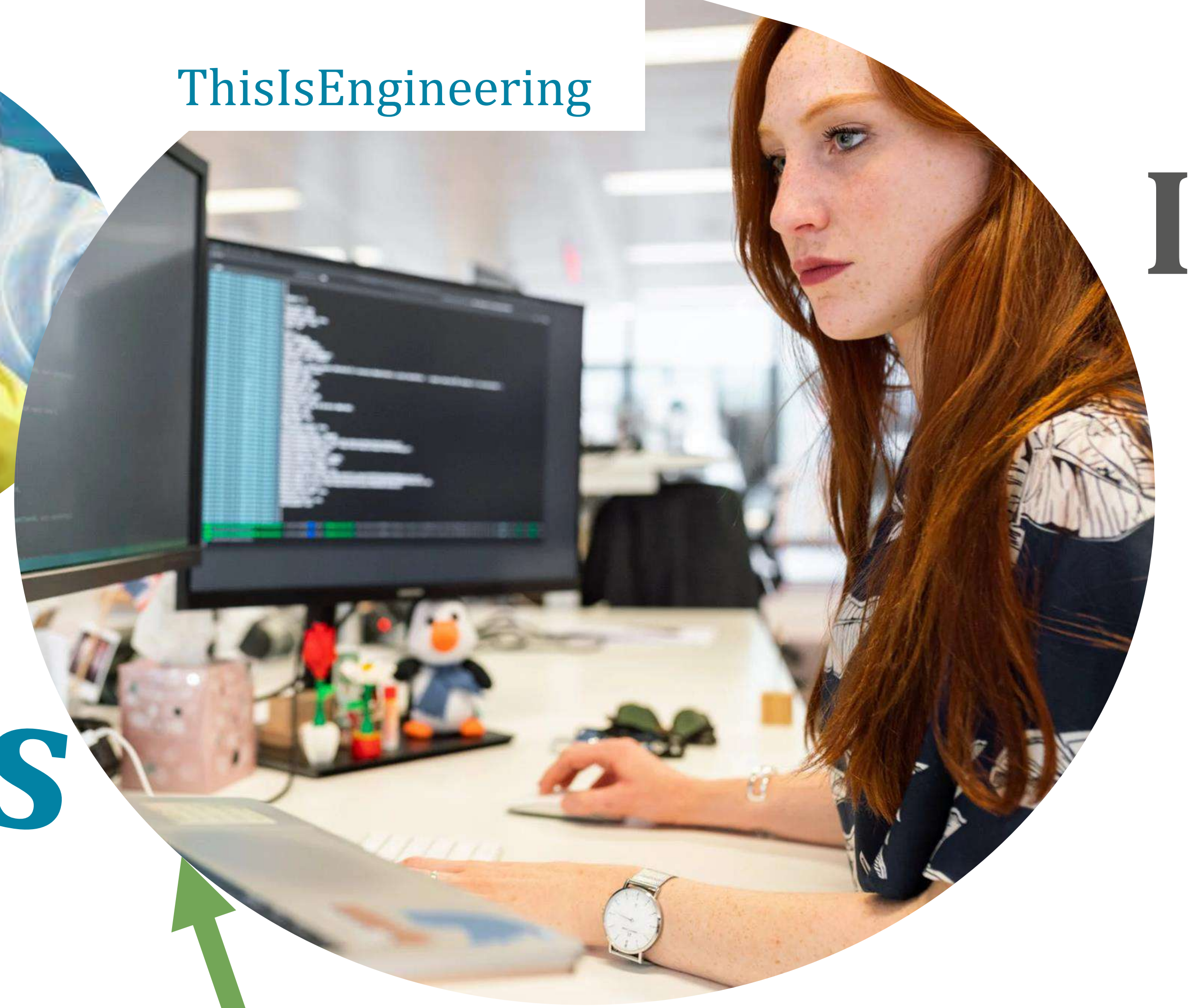
3) Future carbon risk

Evidence-based uncertainty

Douglas Kelley (UKCEH) Chantelle Burton (UKMO) Rhys Whitley (Suncorp) Rahayu Adzhar (Uni of Miami) France Gerard (UKCEH) Megan Brown (OU) Dong Ning (Imperial) Camilla Mathison (UKMO) Chris Huntingford (UKCEH) Toby Marthews (UKCEH) Joshua Chew (U. of Sydney) Rob Parker (NCEO) Tiina Kurvits (GRID) Elaine Baker (GRID) Ioannis Bistinas (Cognizant Benelux) Andrew Sullivan (CSIRO) Gabriel Labbate (UNEP)

What I'd like to doing

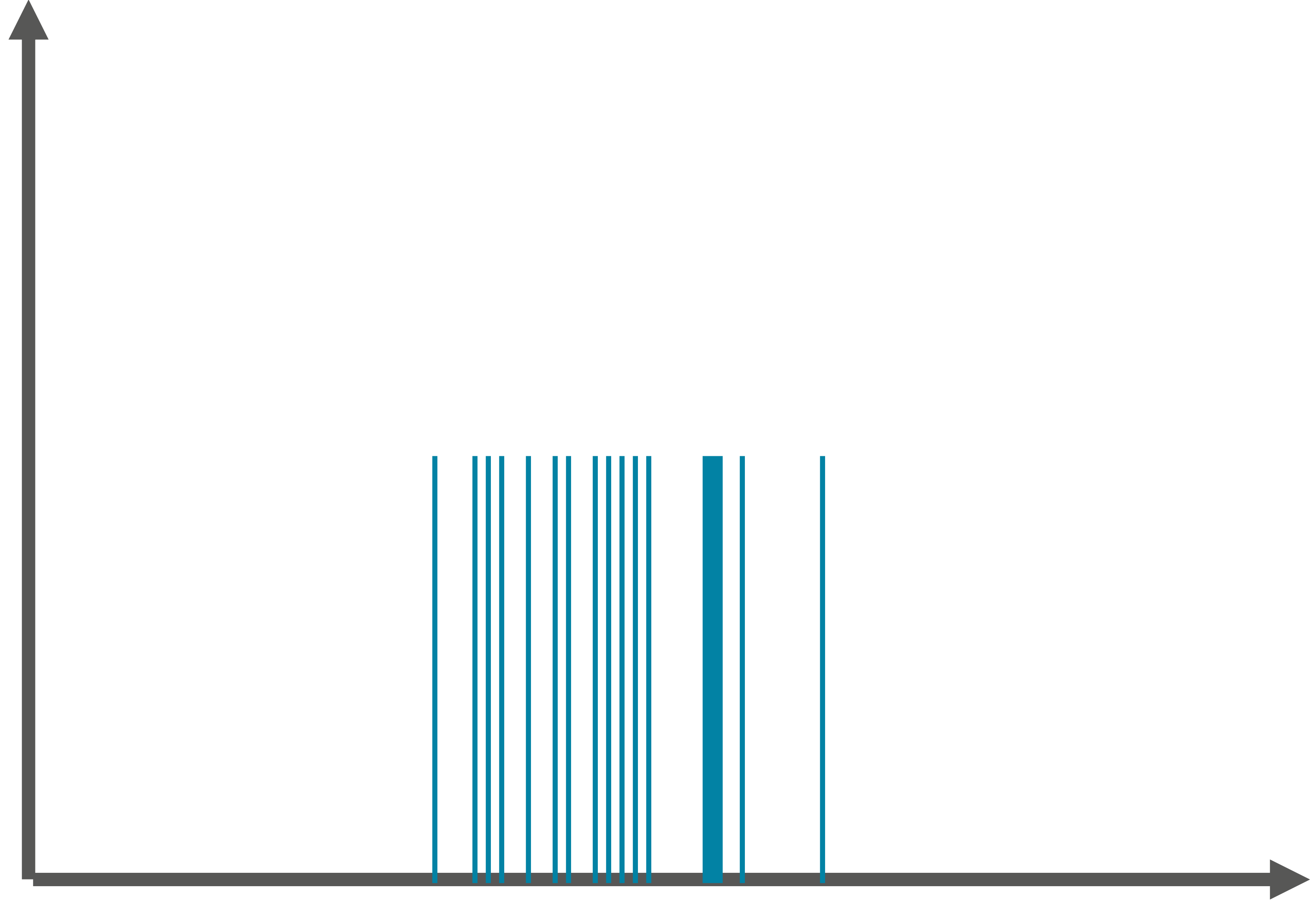
Artem Podrez



ThisIsEngineering

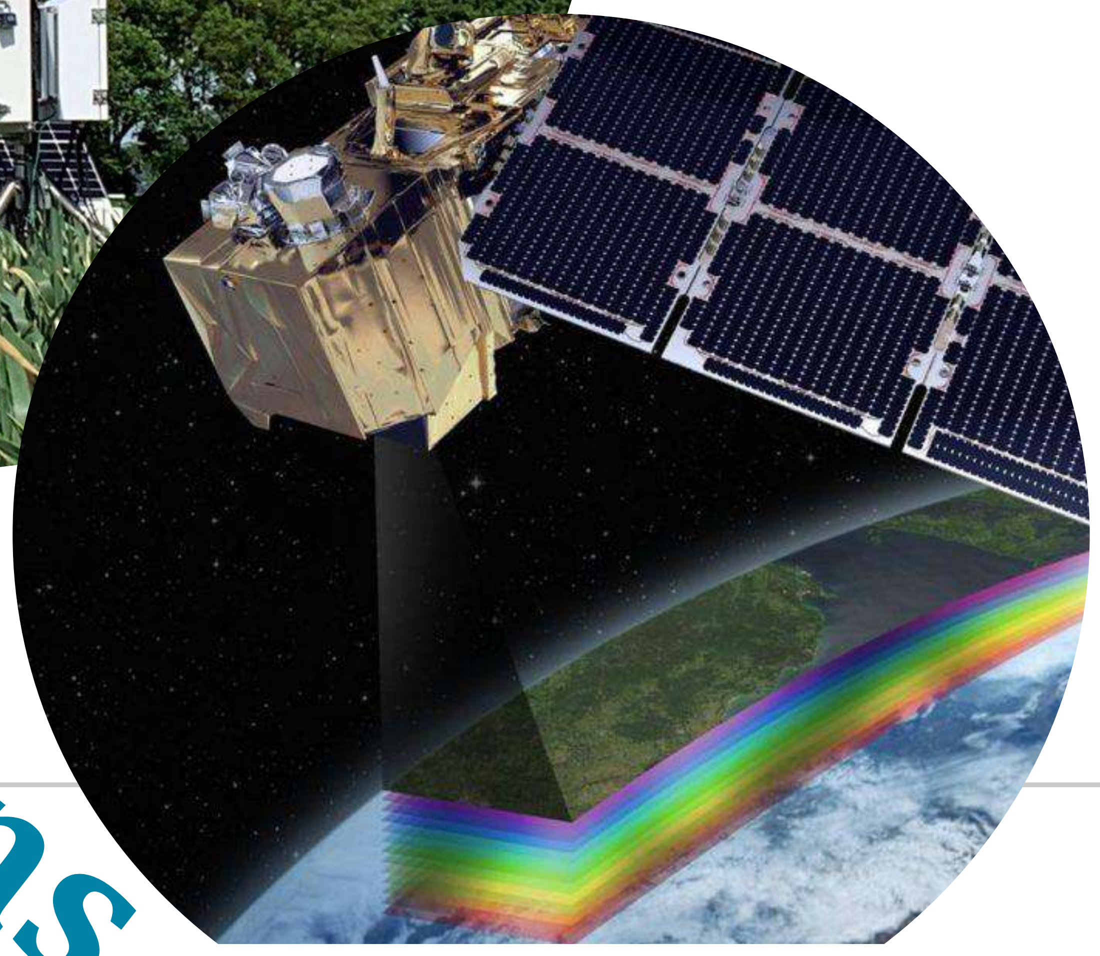
Experts

Interpret



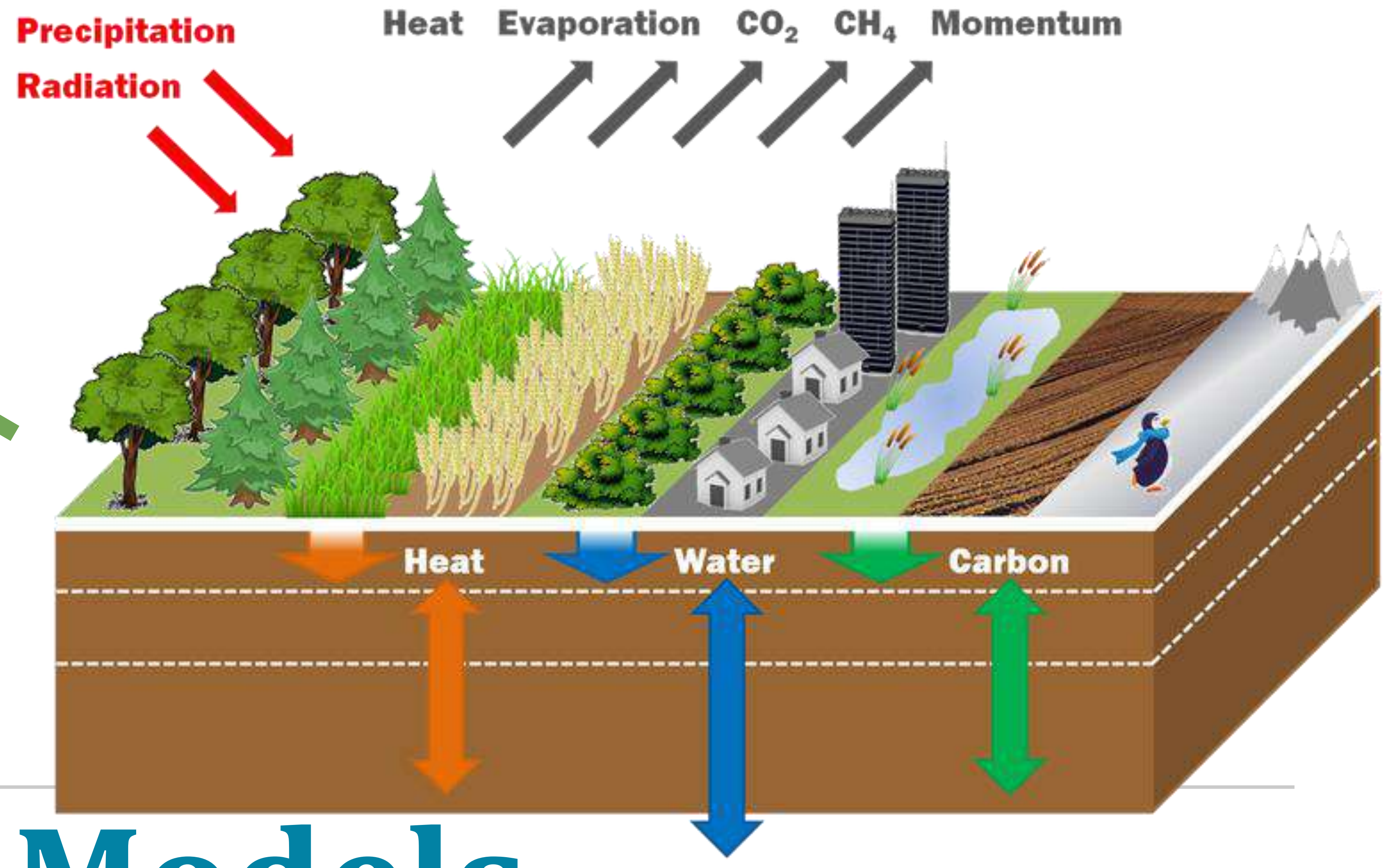
Evaluate

Alex Cumming



Cervest. earth

Observations



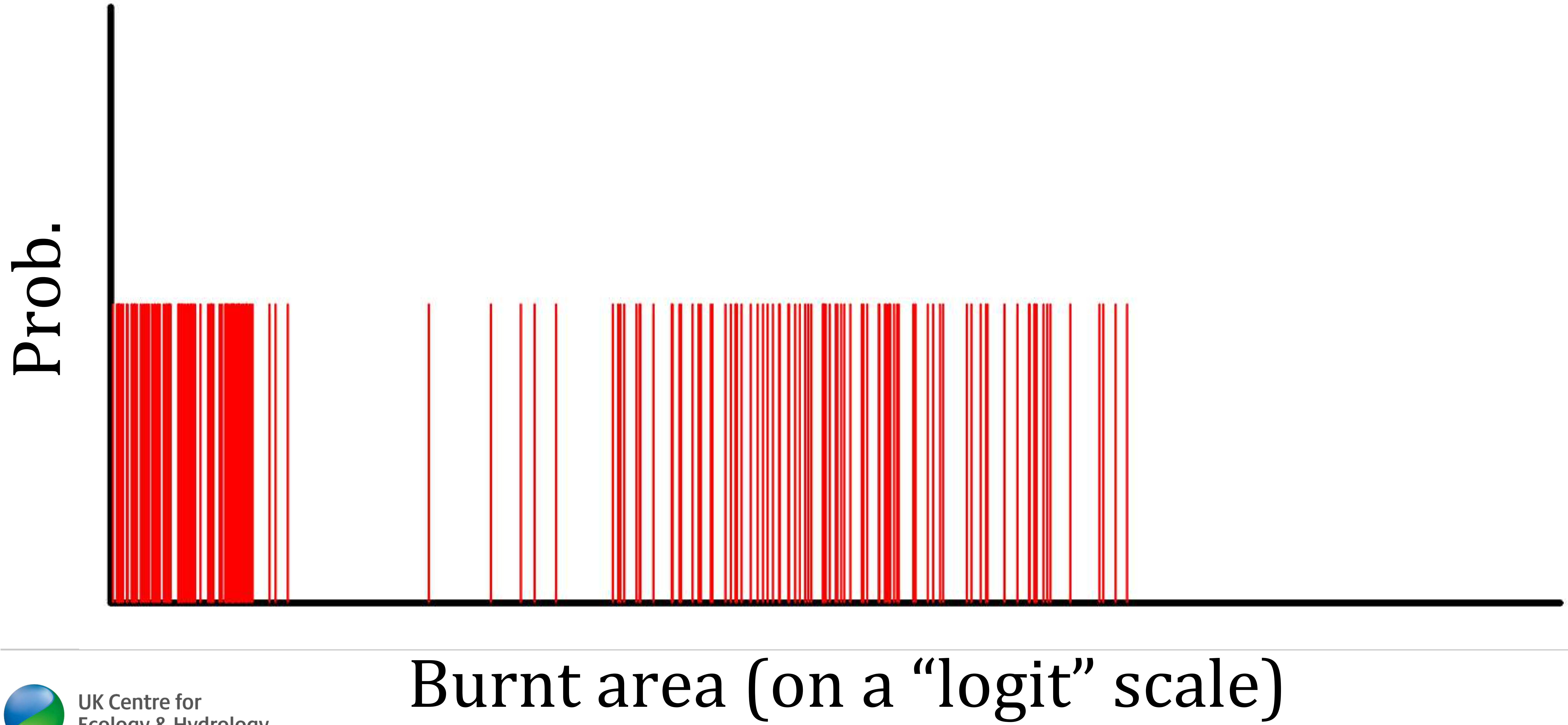
Models

- Tests expert opinion with evidence reducing confirmation bias

- Uncertainty preserved through analysis, and different models complement each others output rather than disagree.

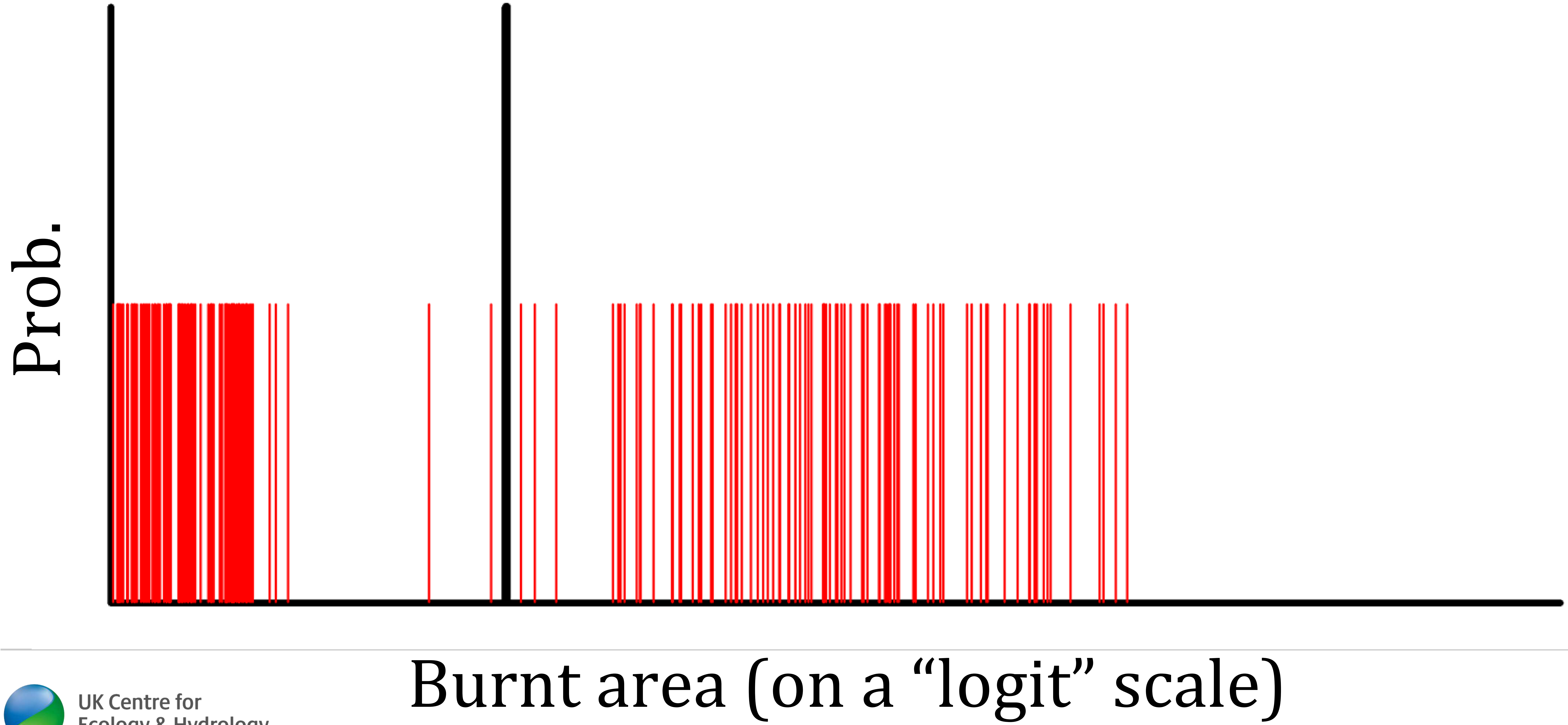
- **Outputs flow directly from evidence.**

Bayesian representation under "same" bioclimatic conditions (fuel ~0.5; 0.8 < flammability)

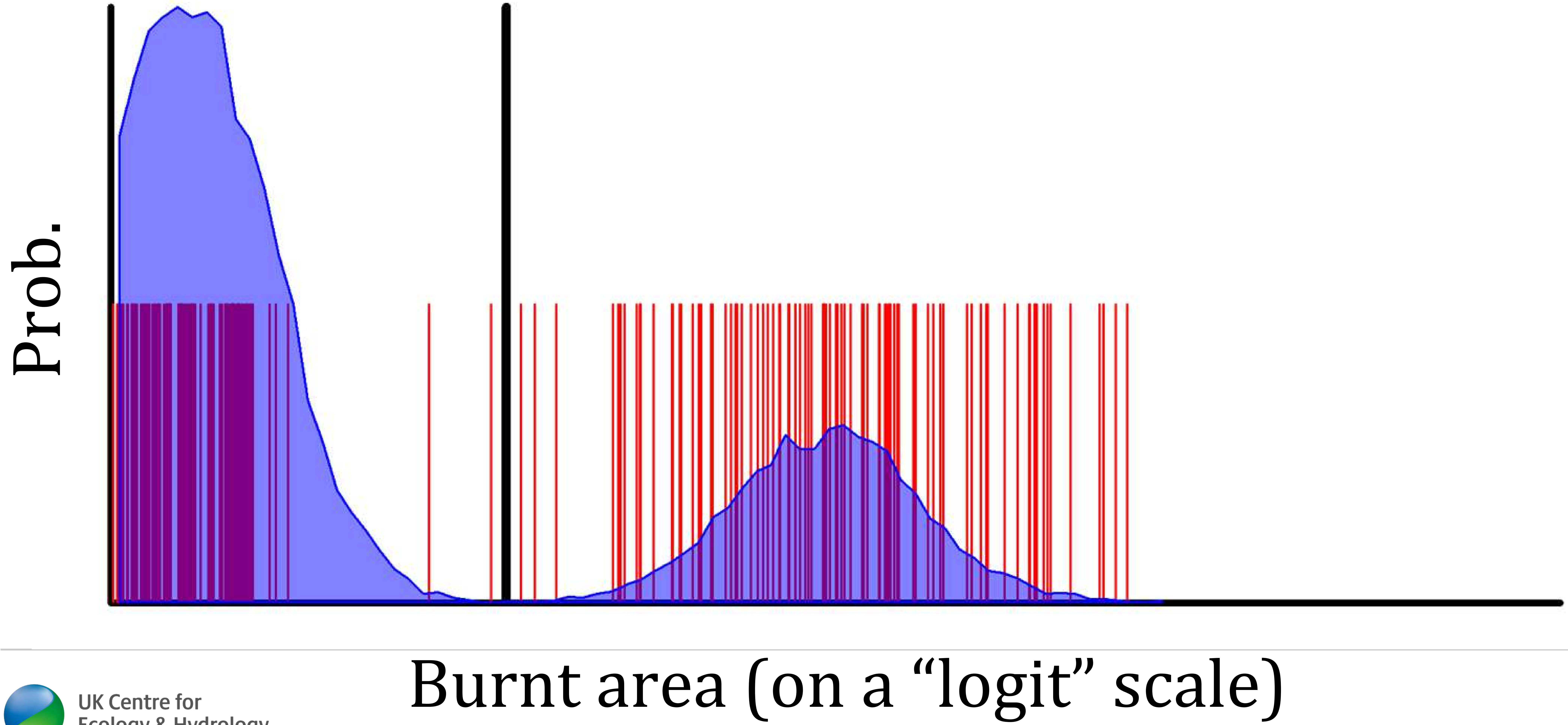


UK Centre for Ecology & Hydrology

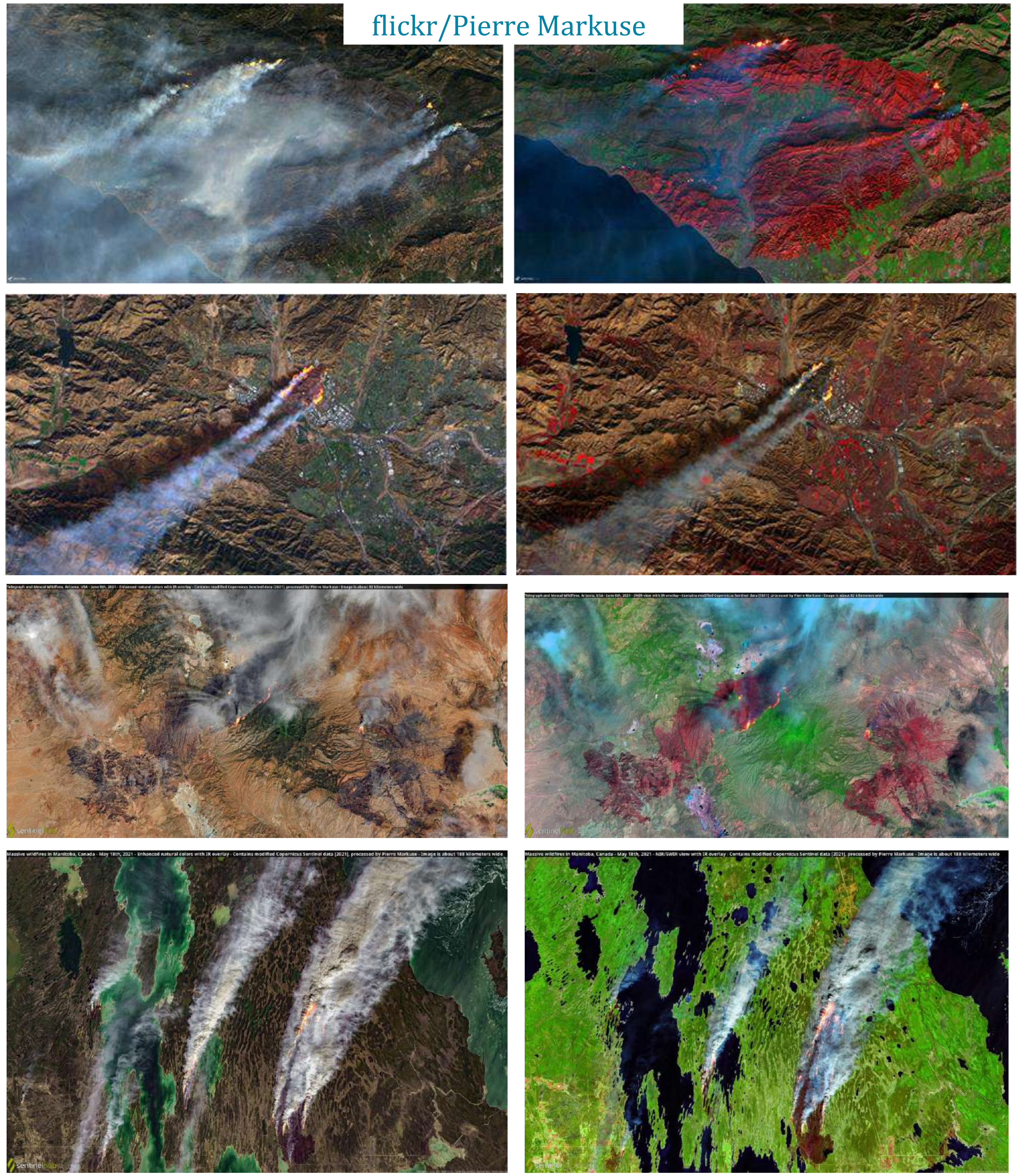
Bayesian representation under "same" bioclimatic conditions

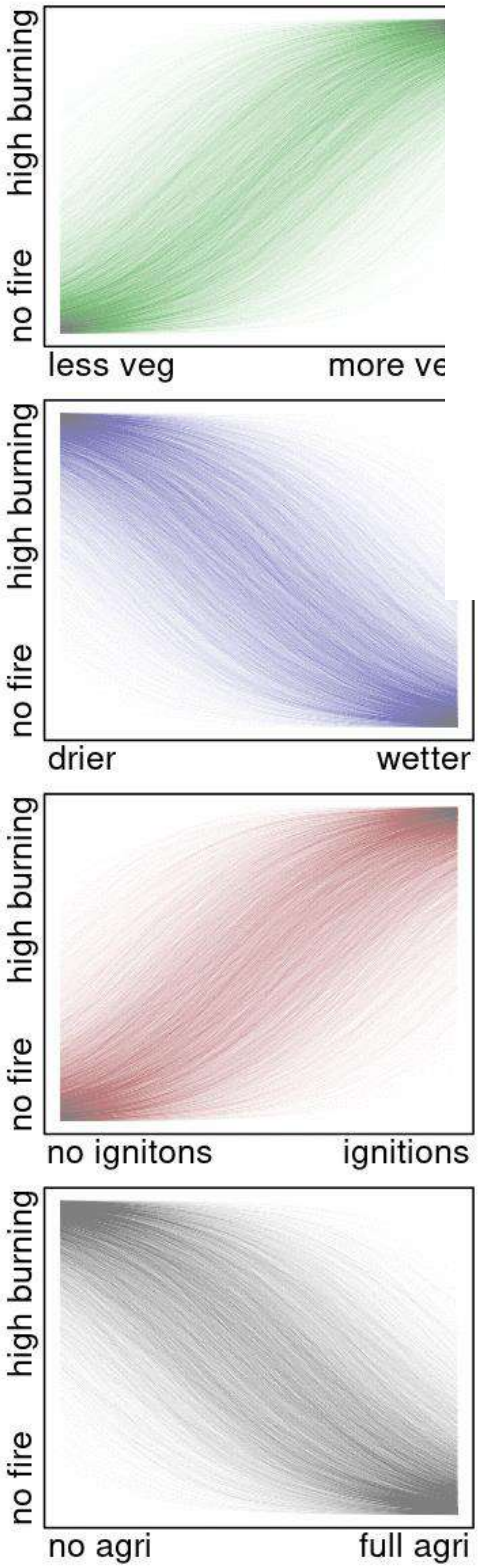


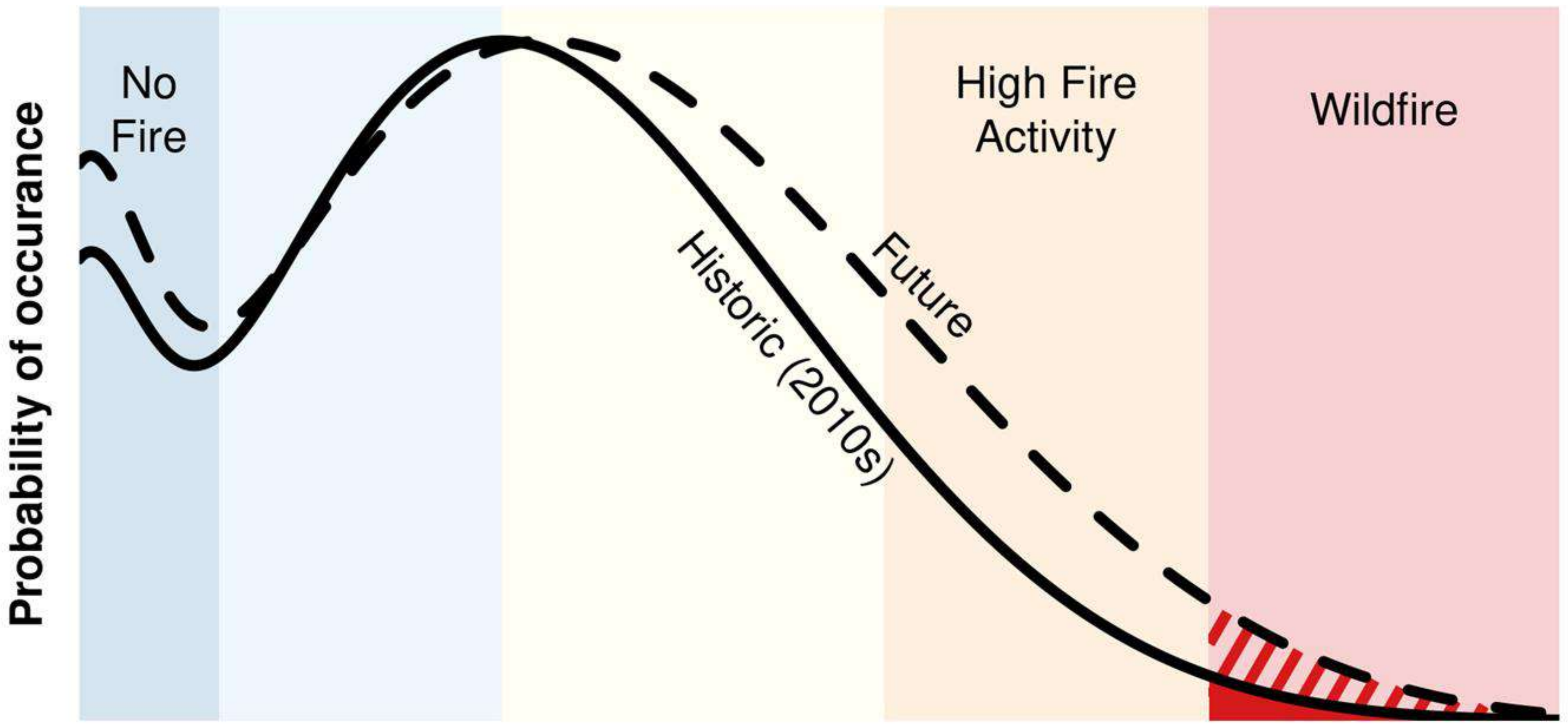
Bayesian representation under "same" bioclimatic conditions

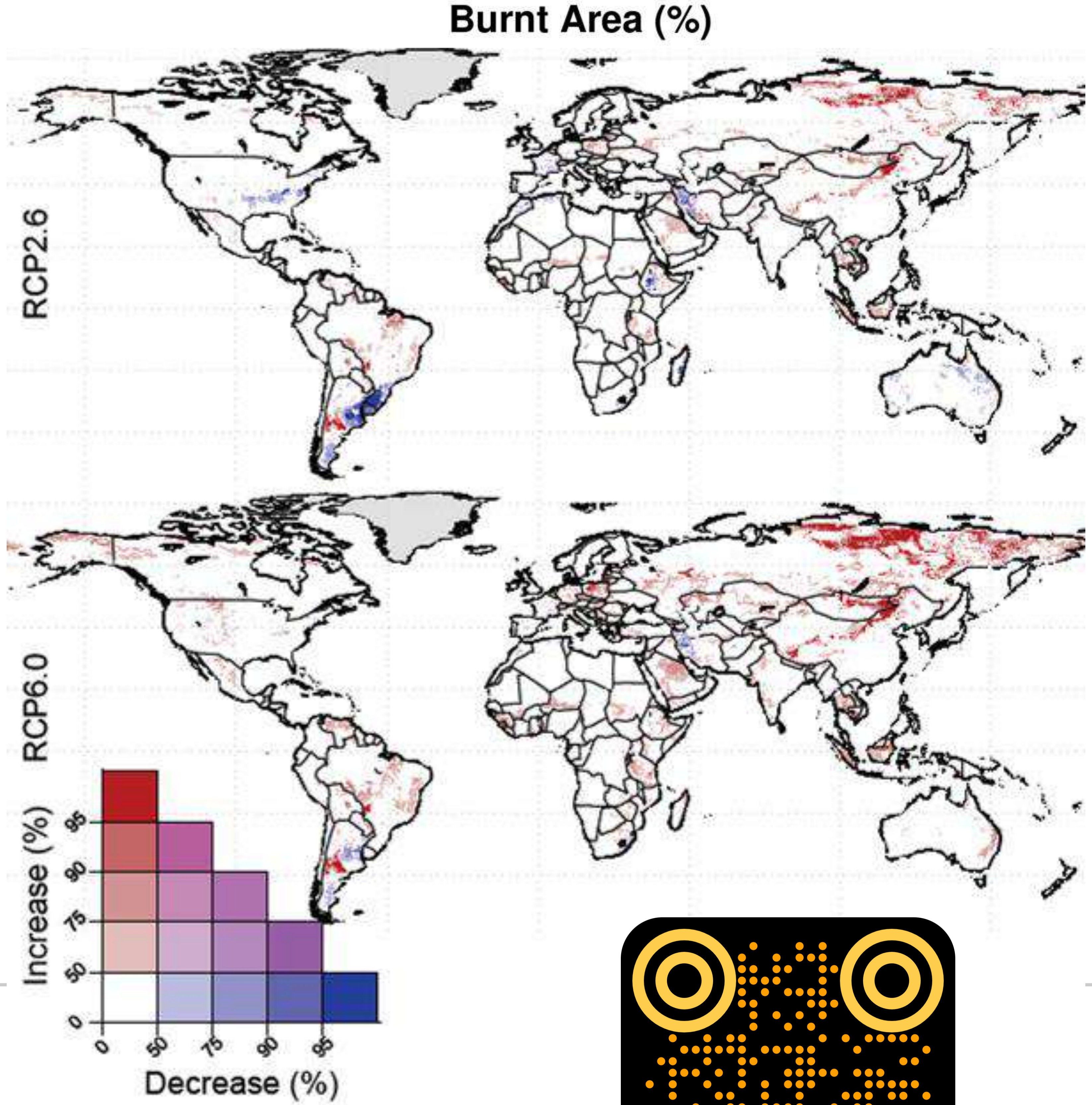


ConFire









UK Centre for Ecology & Hydrology

Support the Guardian
Available for everyone, funded by readers
Subscribe → Contribute →

The Guardian
News website of the year

News | Opinion | Sport | Culture | Lifestyle | More

UK World Coronavirus Climate crisis Football Business Environment UK politics Education Society Science Tech

The age of extinction
Wildfires

Wildfires likely to increase by a third by 2050, warns UN

Even previously unaffected countries likely to see uncontrollable blazes, says study, which calls for shift to spending on prevention

The age of extinction is supported by
the guardian .org
About this content

Phoebe Weston
@phoeb0
Wed 23 Feb 2022 06.00 GMT

Wildfires in California. A new report warns that extreme fires that ravaged the US, Australia and Siberia will become more common by the end of the century. Photograph: David Swanson/Reuters

Wildfires that have devastated California, Australia and Siberia will become 50% more common by the end of the century, according to a new report that warns of uncontrollable blazes ravaging previously unaffected parts of the planet.

UN environment programme 50 1972-2022

GRID ARENDAL
A UNEP Partner

A RAPID RESPONSE ASSESSMENT

SPREADING LIKE WILDFIRE

THE RISING THREAT OF EXTRAORDINARY LANDSCAPE FIRES

Mail Online Science & Tech

Home | News | U.S. | Sport | TV&Showbiz | Australia | Femail | Health | Science | Money | Video | Travel | Best Buys | Discounts

Extreme wildfires could increase by up to 50% by 2100 amid rising global temperatures, study warns

- UN report finds climate change and lanc
- It predicts a global increase of extreme
- Governments are now urged to invest m
- Report coincides with wildfires blazing t

By JONATHAN CHADWICK FOR MAILONLINE
PUBLISHED: 06:05, 23 February 2022 | UPDATED:

INDEPENDENT

NEWS INDEPENDENT TV CLIMATE SPORT VOICES CULTURE PREMIUM INDY/LIF

A warming planet and land use changes mean more wildfires will scorch large parts of the globe in coming decades

Via AP news wire • Wednesday 23

The New York Times

Climate Scientists Warn of a 'Global Wildfire Crisis'

Worsening heat and dryness could lead to a 50 percent rise in off-the-charts fires, according to a United Nations report.

By Raymond Zhong
Published Feb. 23, 2022 Updated Feb. 28, 2022

A landmark United Nations report has conclu devastating wildfires around the world will su decades as climate change further intensifies

atterns mean more wildfires
decades, causing spikes in
ns that governments are ill
port being released

sky news

Home UK World Politics US Climate Science & Tech Business Ents & Arts Travel Offbeat More

Watch Live

Risk of wildfires could rise by 50% by end of the century with previously untouched Arctic under threat, report warns

The report warns things have got so bad, even previously unaffected regions such as the Arctic now face an elevated risk of wildfires.

Ian Collier
News reporter

Wednesday 23 February 2022 06:01, UK

NEWS LIVE TV INDIA TODAY APP MAGAZINE

Wildfires getting worse globally, governments unprepared, warns UN

UN researchers said many nations continue to spend too much time and money fighting fires and not enough trying to prevent them.

AP Associated Press
BILLINGS
February 23, 2022 UPDATED: February 23, 2022 14:30 IST

A warming planet and changes to land use patterns mean more wildfires will scorch large parts of the globe in coming decades, causing spikes in unhealthy smoke pollution and other problems that governments are ill prepared to confront, according to a U.N. report being released Wednesday.

BBC NEWS

Home | War in Ukraine | Coronavirus | Climate | UK | World | Business | Politics | Tech | Science | Health

Science & Environment

Global warming and land use change to drive more extreme wildfires

By Matt McGrath
Environment correspondent

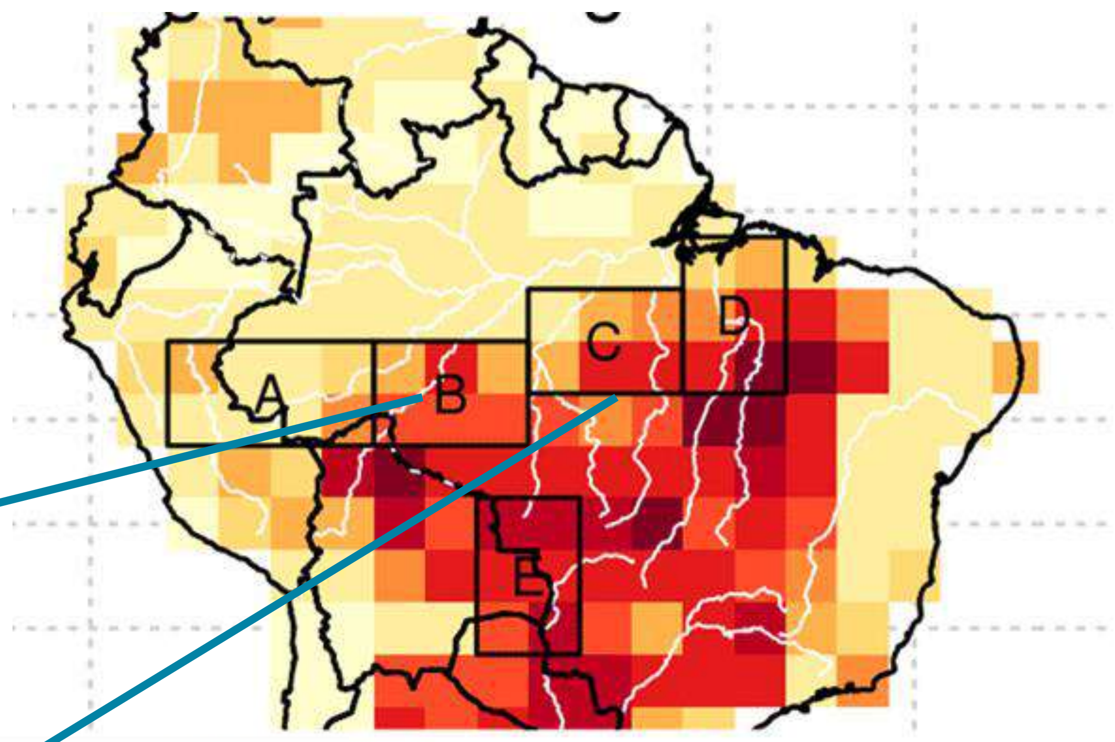
7 days ago

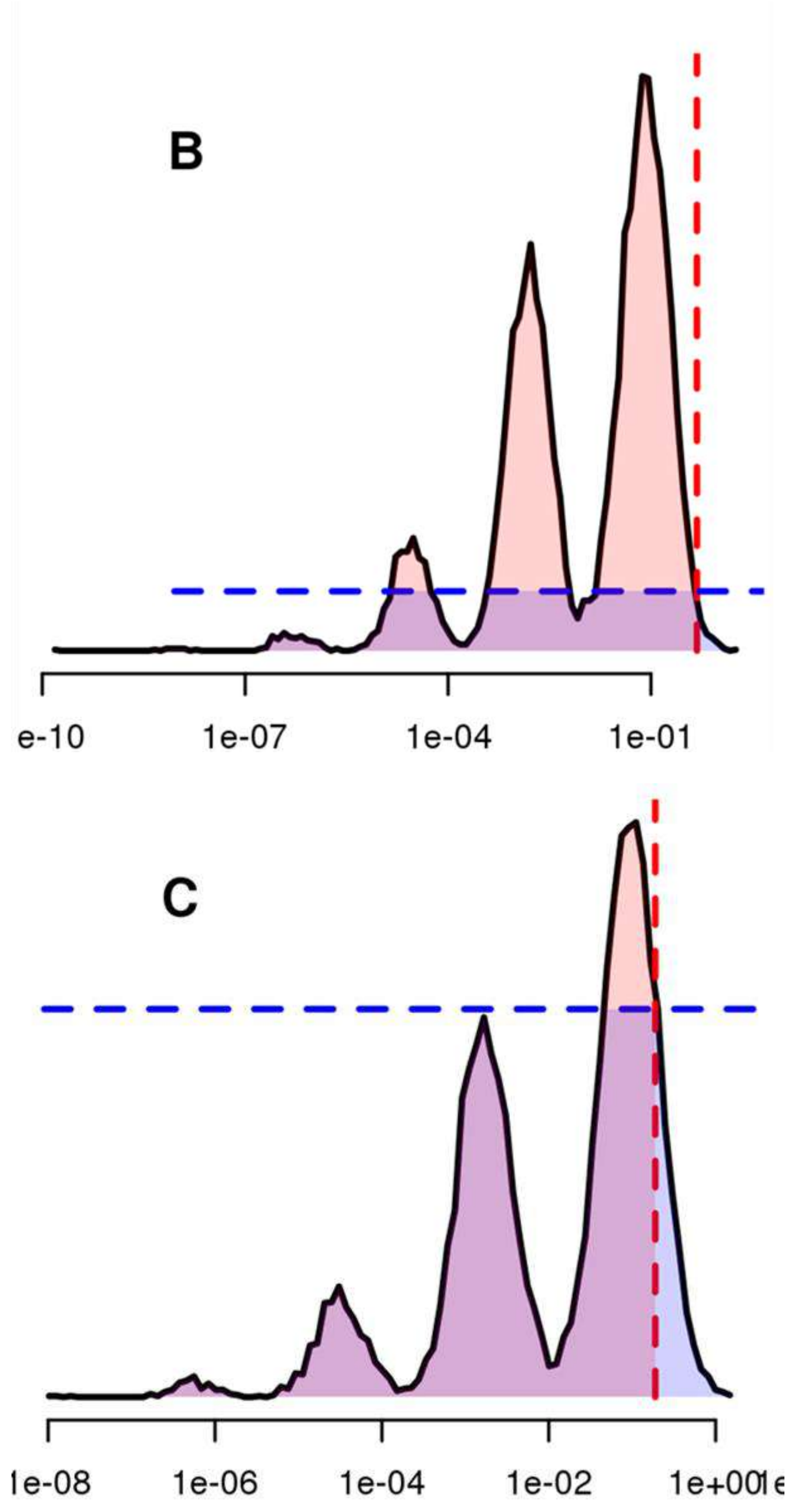
Australia fires

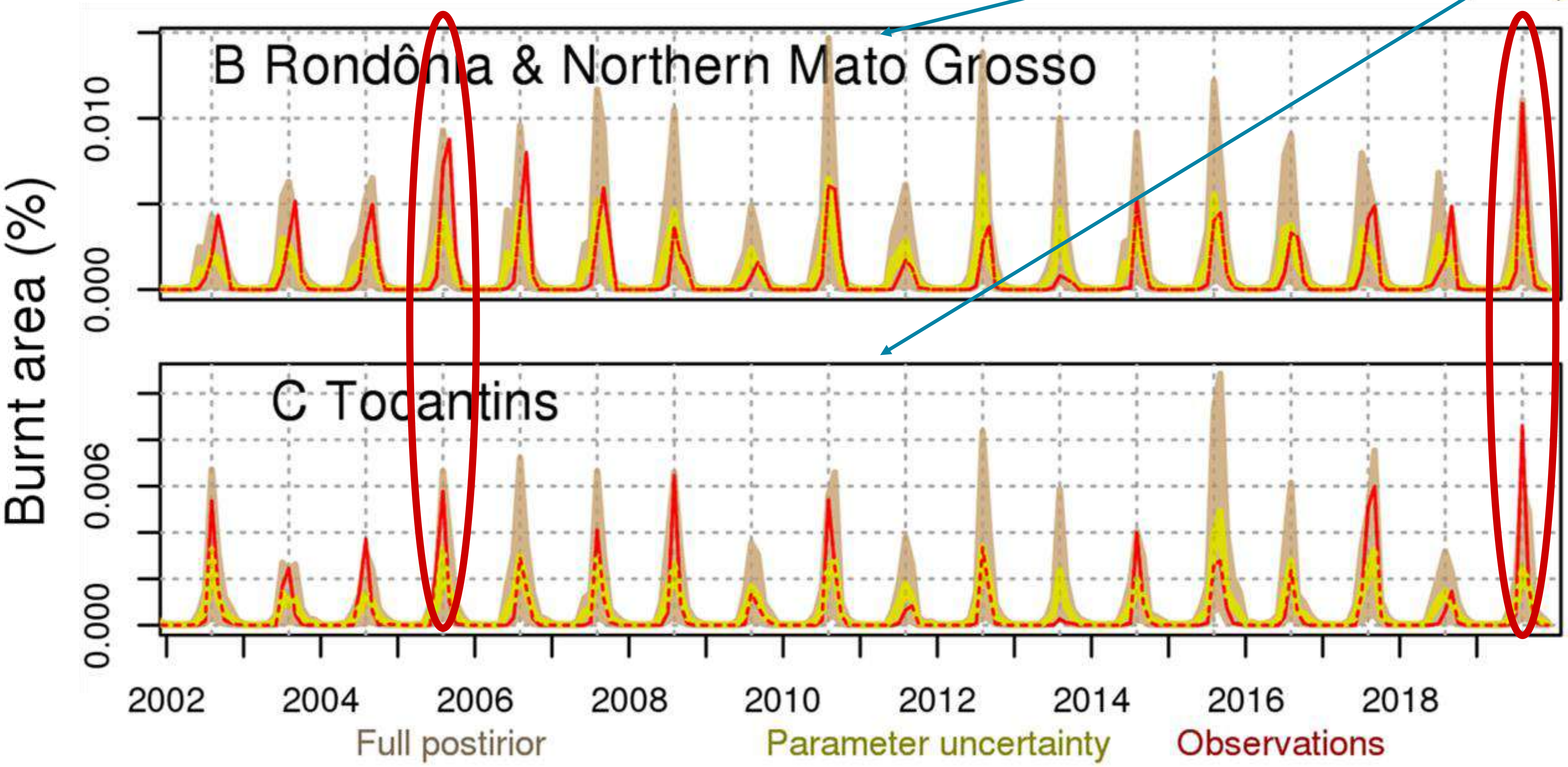
Extreme wildfires are set to become more frequent, increasing by around 50% by the end of this century, according to a new UN report.

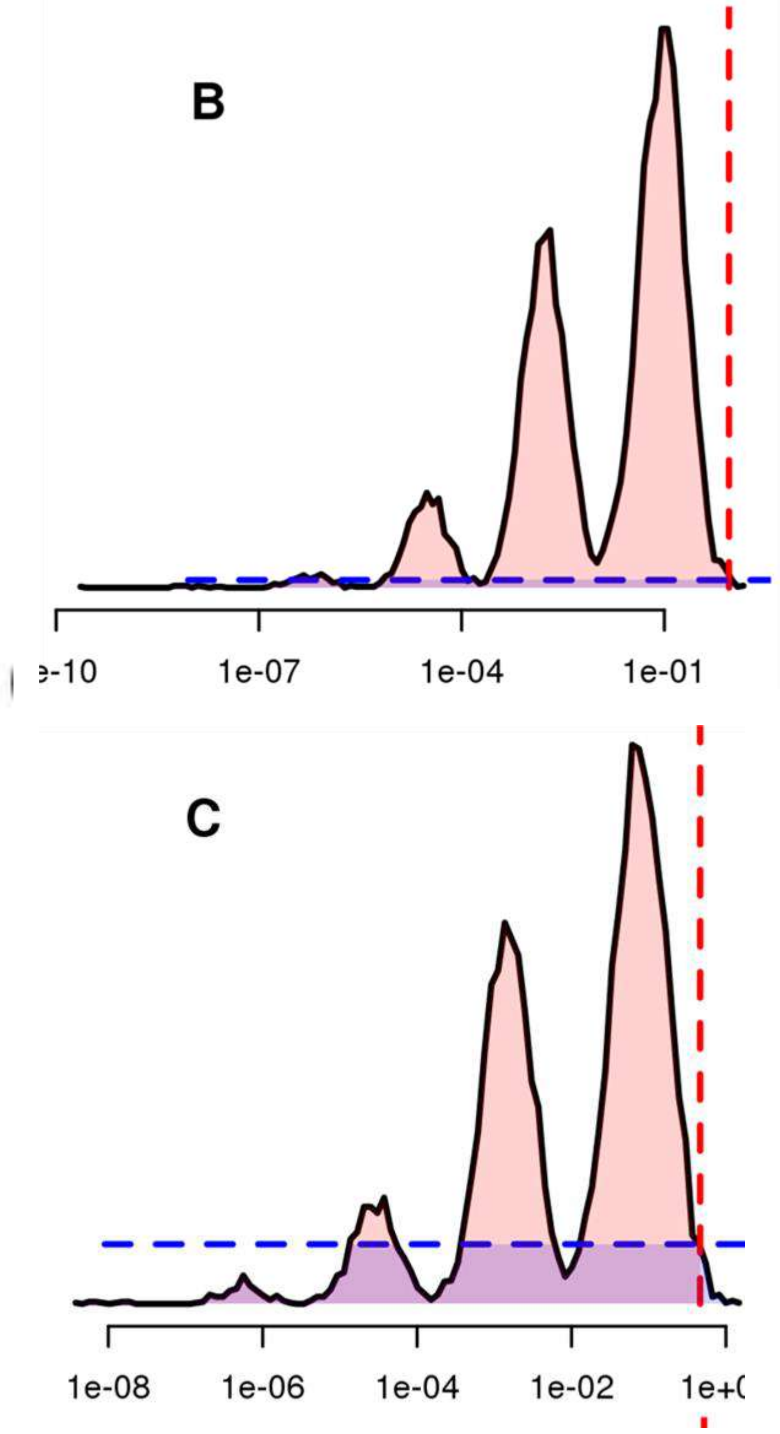
The report finds there's an elevated risk in the Arctic and other regions previously unaffected by fires.

Amazonia 2019 fires attribution







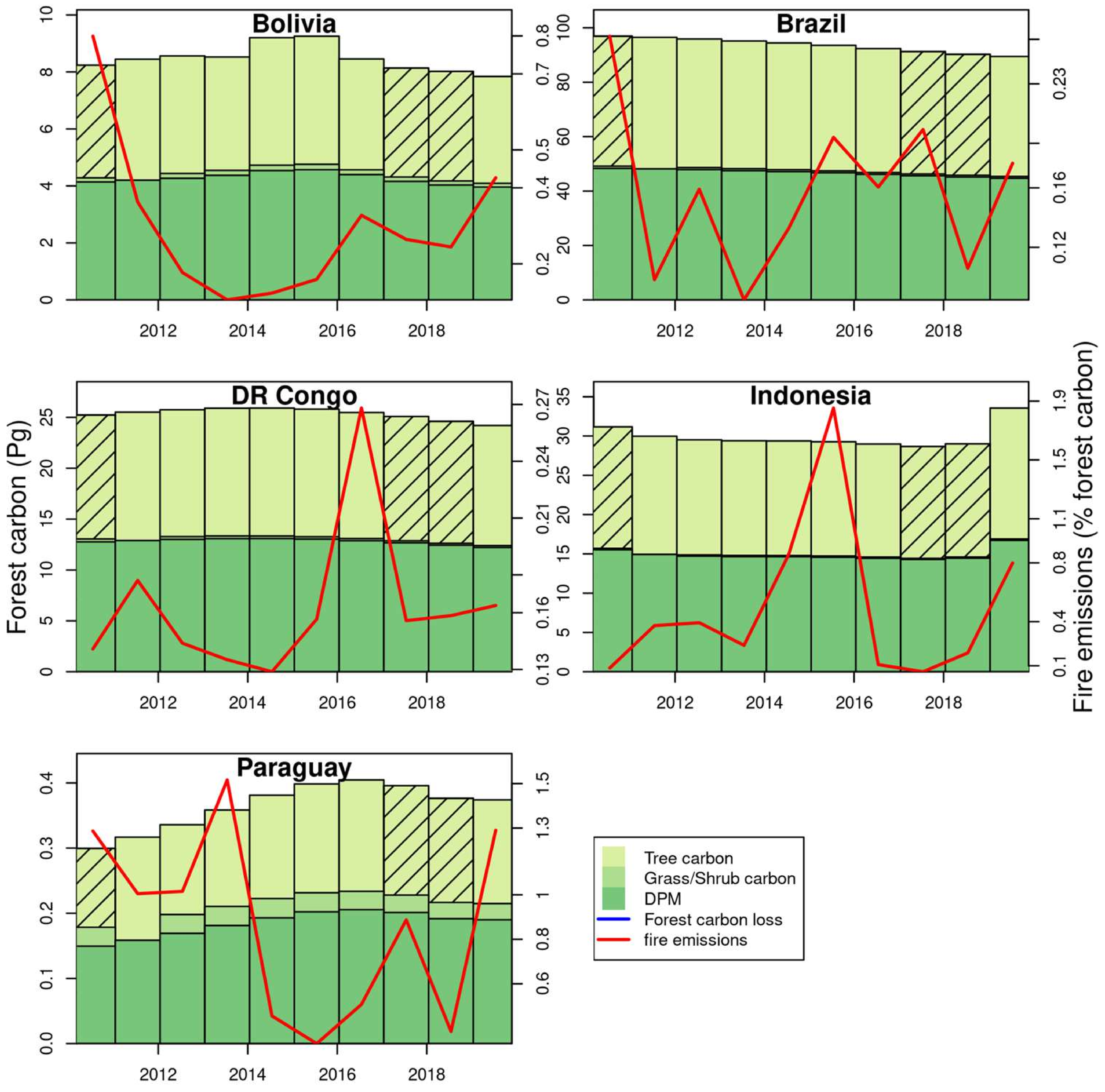


Kelley et al (2021) Technical note: Low meteorological influence found in 2019 Amazonia fires, doi:0.5194/bg-18-787-2021,

What I’m paid to do

Historic carbon losses

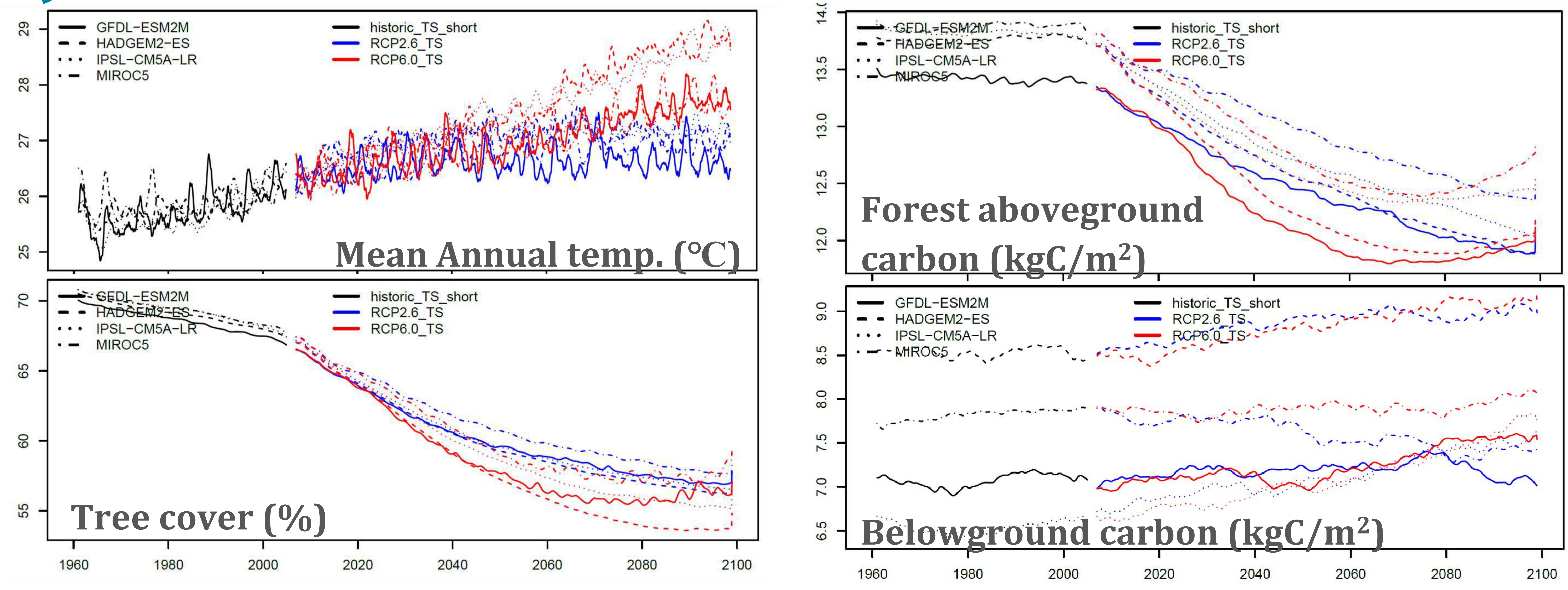
Combining satellite observations and JULES-ES simulations to estimate forest carbon (green) and the % lost to fire each year (red)

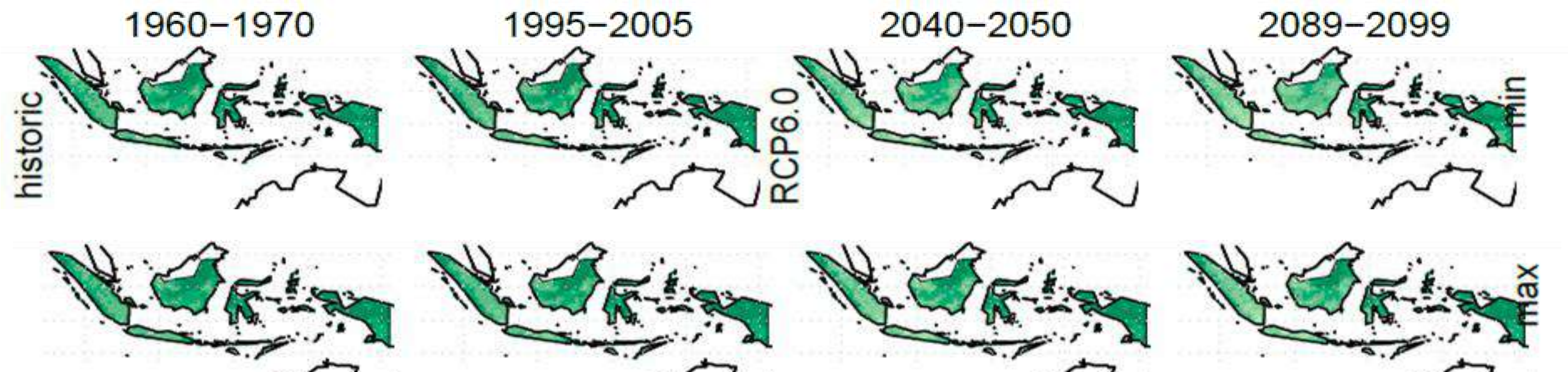


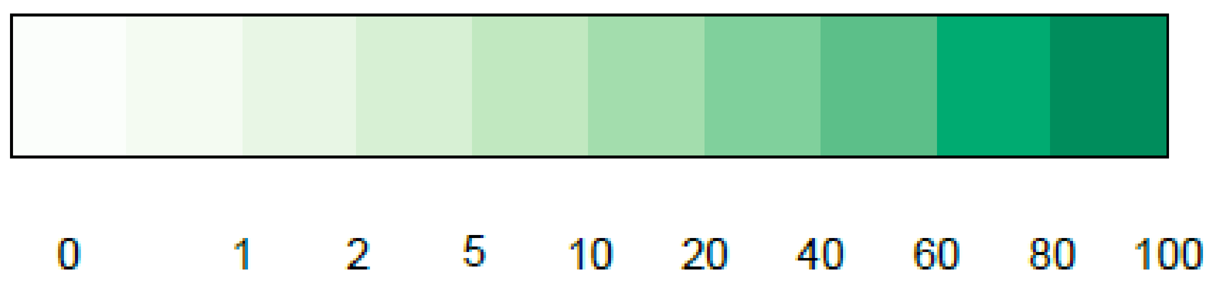
Sullivan et al (in press) Spreading like Wildfire: The Rising Threat of Extraordinary Landscape Fires, UNEP RRA

UK Centre for Ecology & Hydrology

JULES-ES-ISIMIP

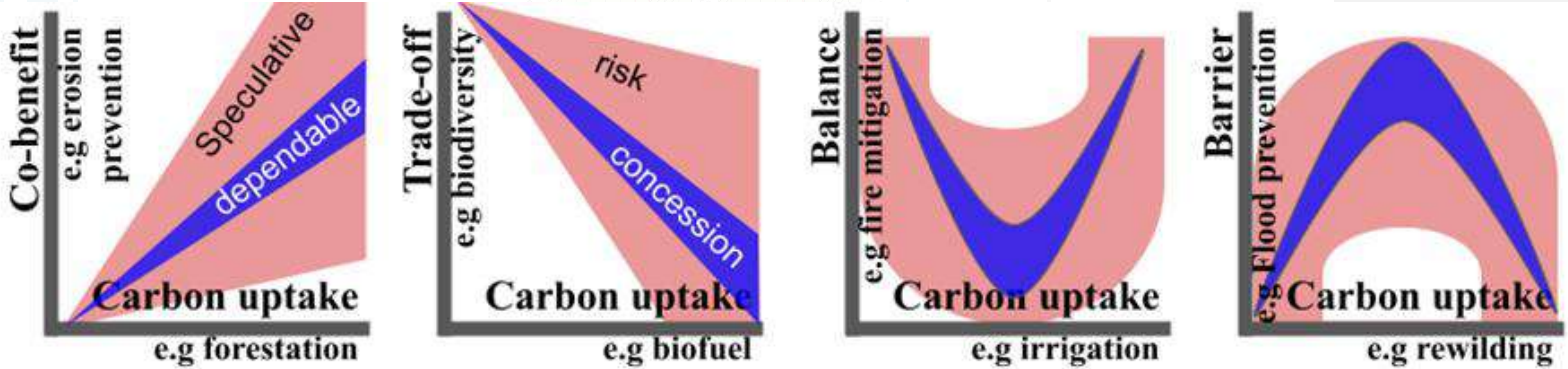






What I'd like to do in Net0+

	Monitoring	Projecting
...nce	Matt/Emma - developing near real time JULES to	Emma/Becky/ Sonja - incorpate
Uncert...		...assess confidence in trade-offs/ co-benfits



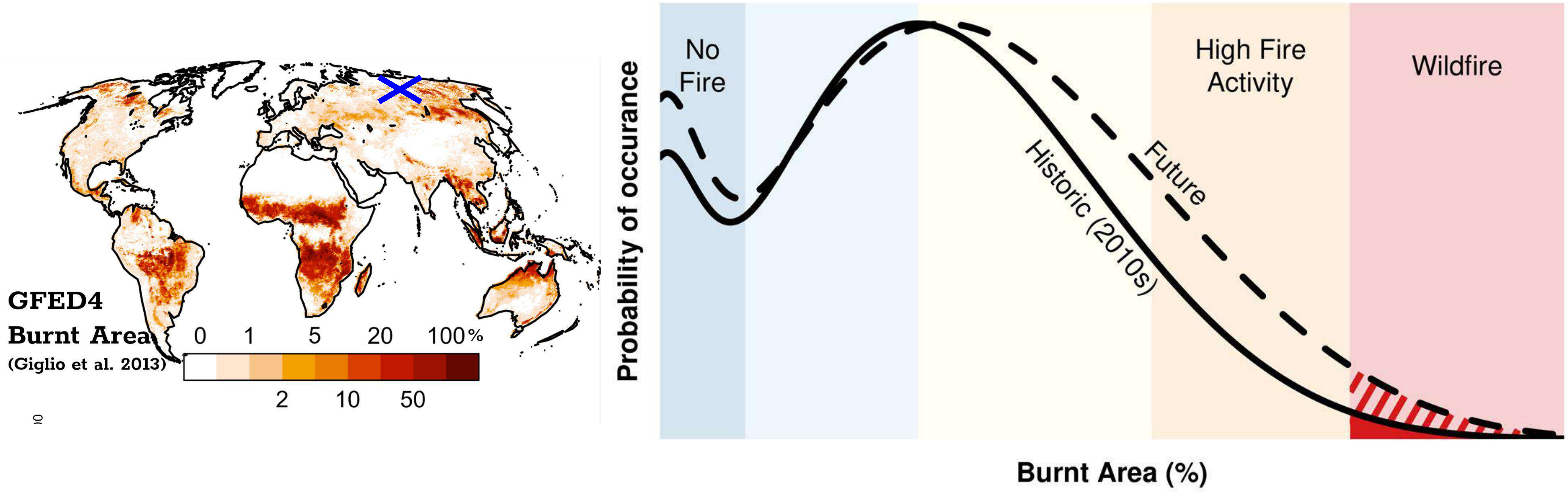
Evidence-based ucertainty

Douglas Kelley (UKCEH) Chantelle Burton (UKMO)
Rhys Whitley (Suncorp) Rahayu Adzhar (Uni of Miami)
France Gerard (UKCEH) Megan Brown (OU)
Dong Ning (Imperial) Camilla Mathison (UKMO)
Chris Huntingford (UKCEH) Toby Marthews (UKCEH) Joshua Chew (U. of Sydney)
Rob Parker (NCEO) Tiina Kurvits (GRID)
Elaine Baker (GRID) Ioannis Bistinas (Cognizant Benelux) Andrew Sullivan (CSIRO)
Gabriel Labbate (UNEP)

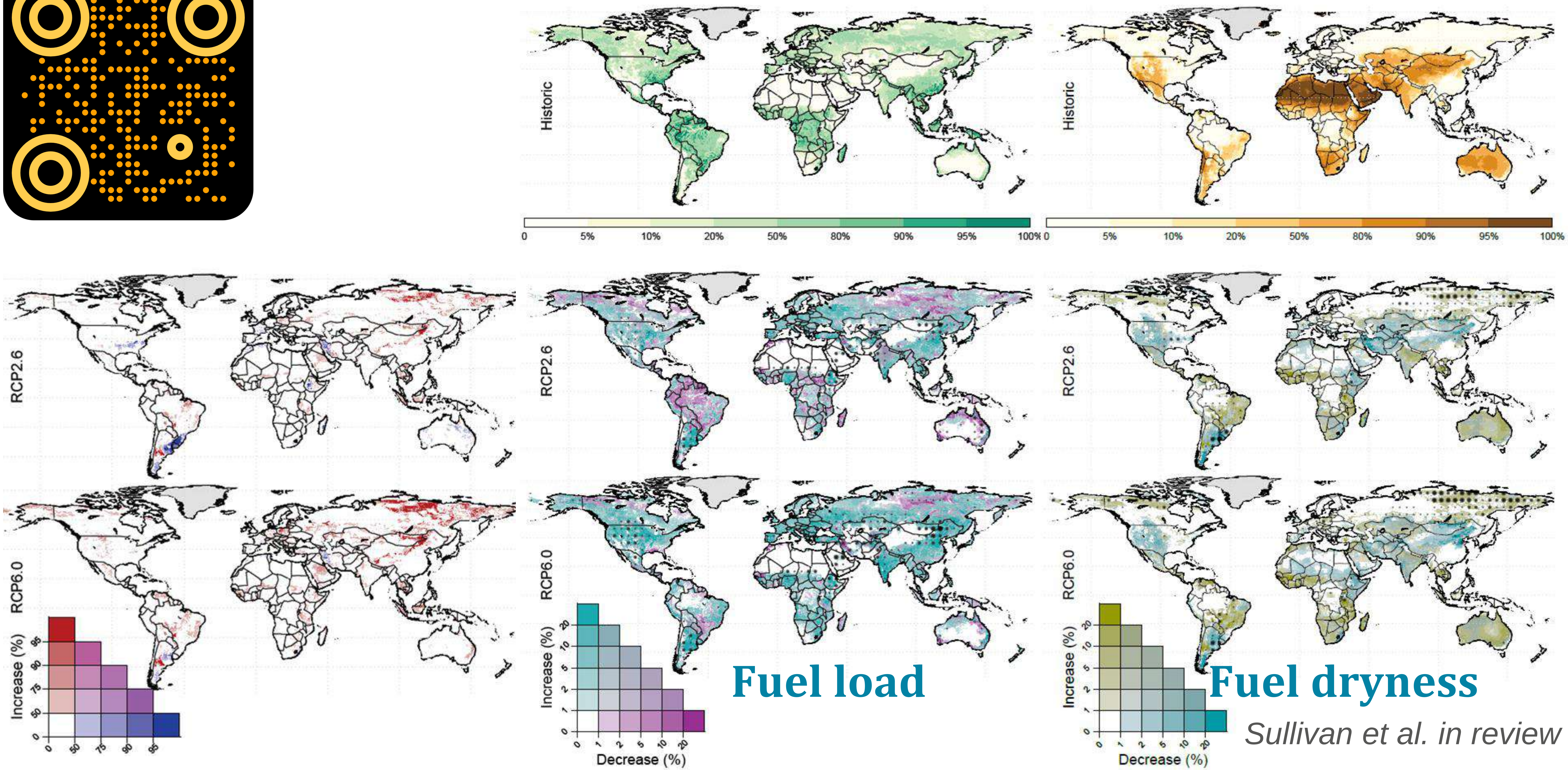
UK Centre for Ecology & Hydrology

Reducing emissions with the aim to limits global warming to 2°C by 2100 will still see some, but much less carbon loss

Wildfires are extreme (1-in-100) burnt areas



Likely changes in wildfire by 2100

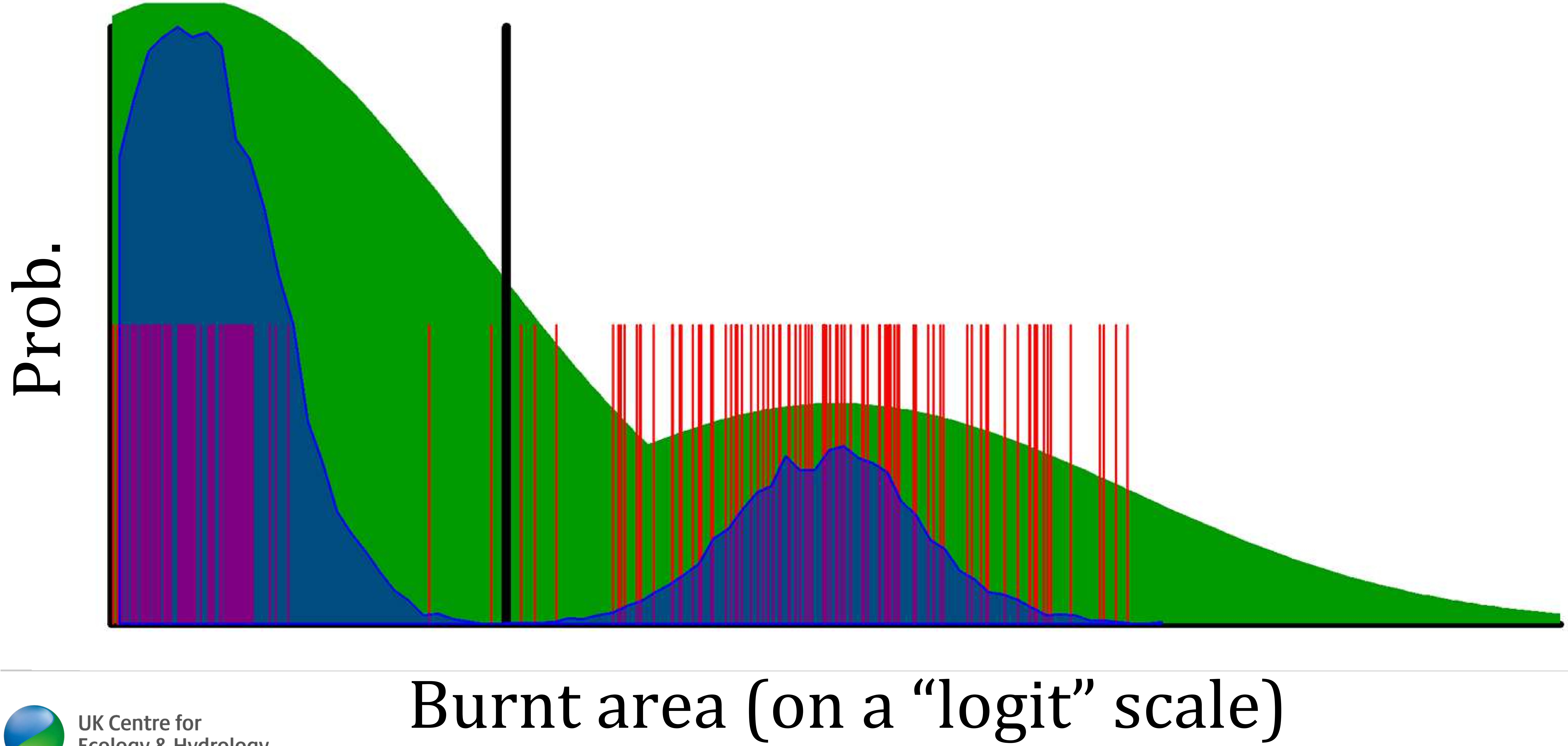


Sullivan et al. in review

Relationships between carbon flux/environmental conditions

How we’ve used it

Bayesian representation under "same" bioclimatic conditions

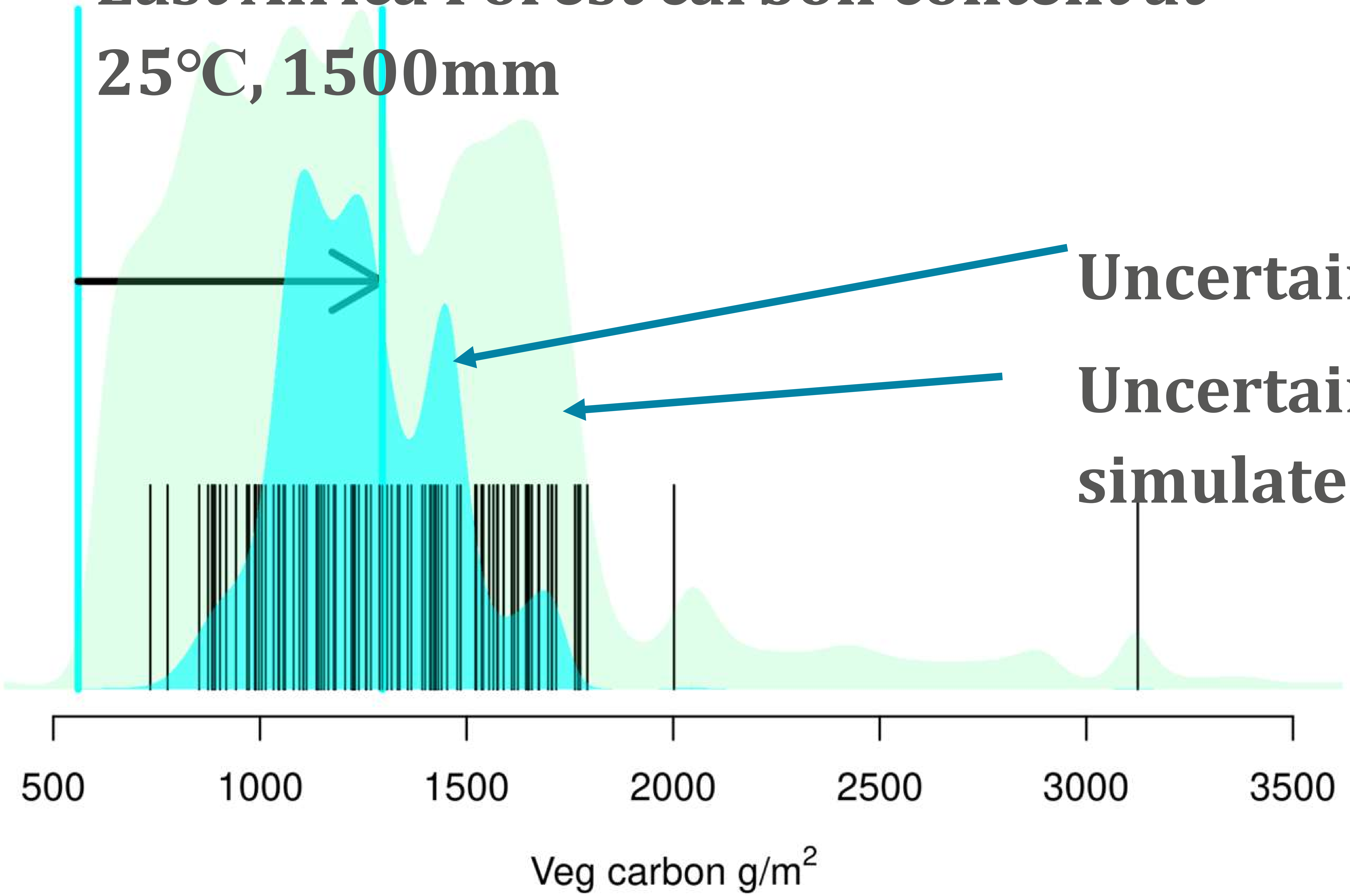


What I do AND like doing :)

- Wildfire as an example using uncertainty quantification to do some super policy-relavent analysis.
    - Future projections
    - Event attibution
    - Historic fire regime drivers.
- Other stuff:
    - Satellite product validation
    - Water body detection
    - Ecosystem demography
    - Last Glacial Maximum veg distribution

Data Assimilation+uncertainty

East Africa Forest carbon content at 25°C, 1500mm



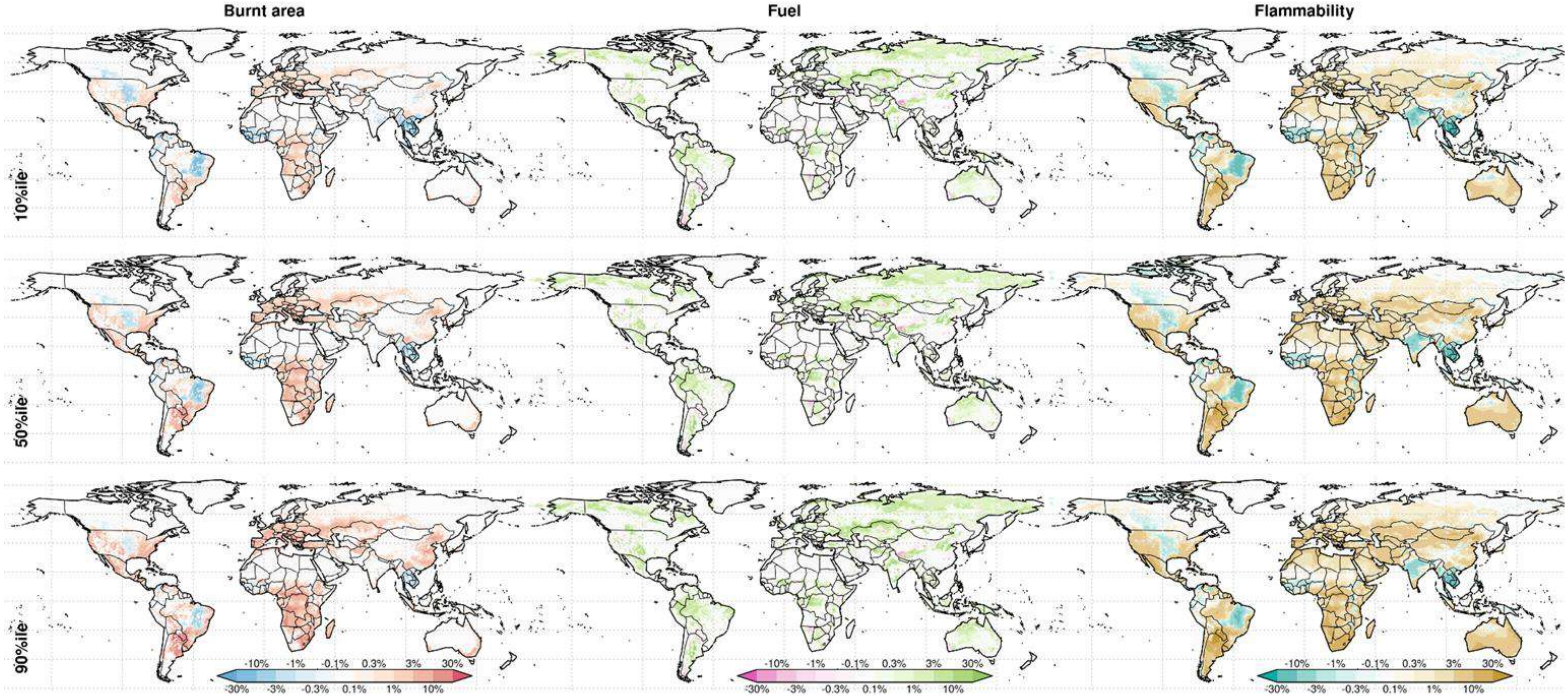
1) Optimize

2) Spread

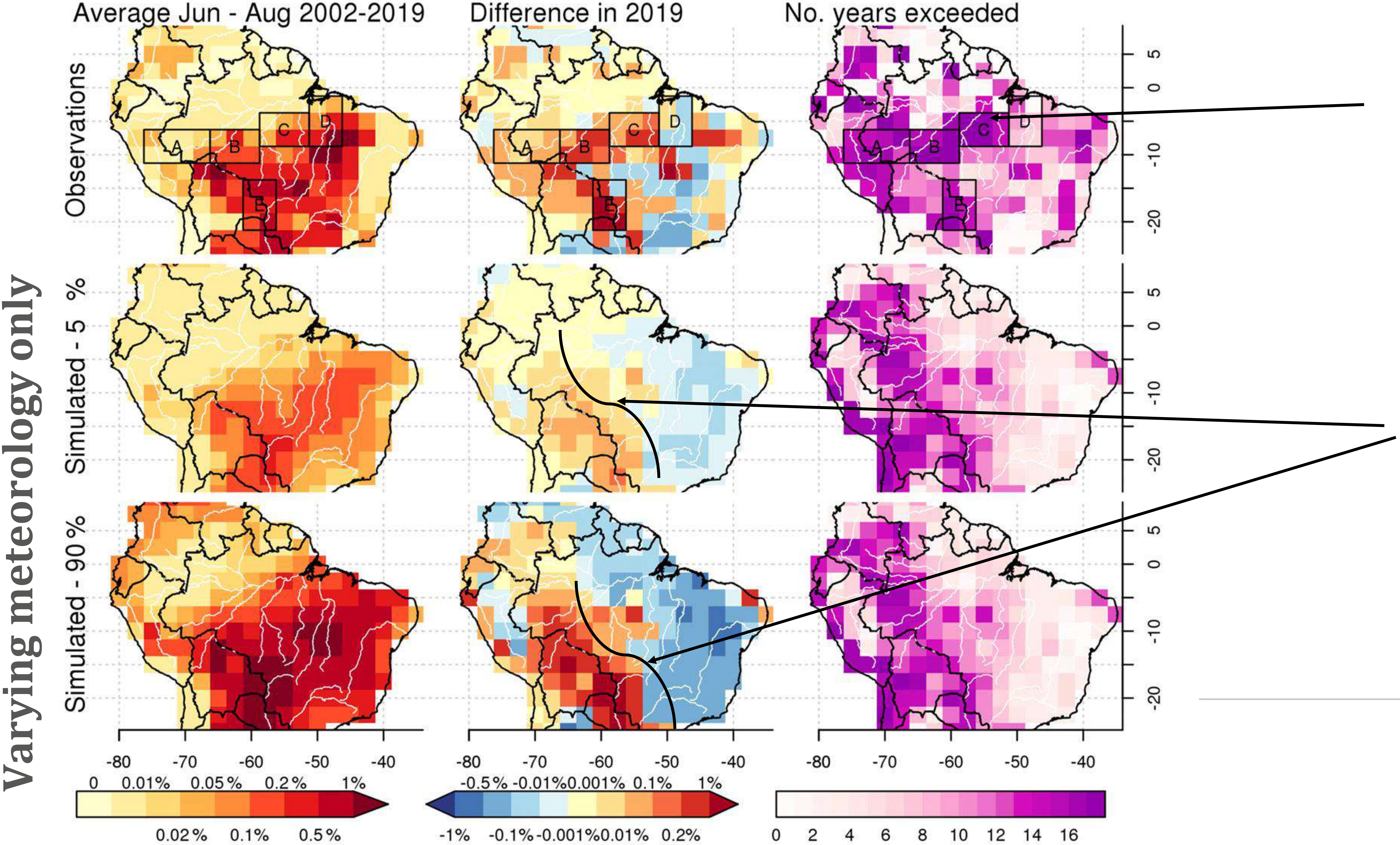
Uncertainty in what's in the model

Uncertainty from what we don’t simulate.

Impact of anthropagenic climate change on burnt area.

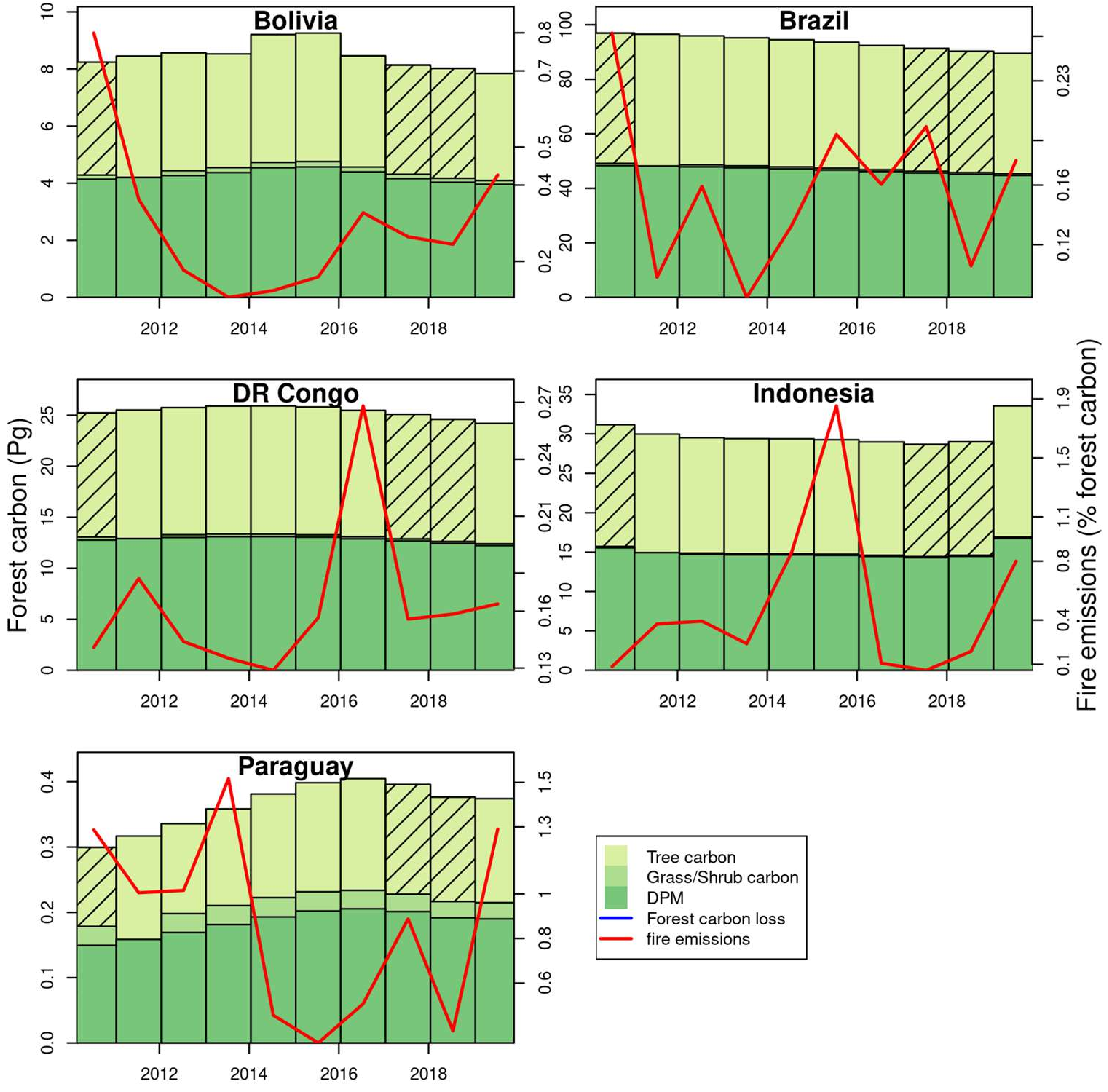


Example: 2019 Amazon burnt area



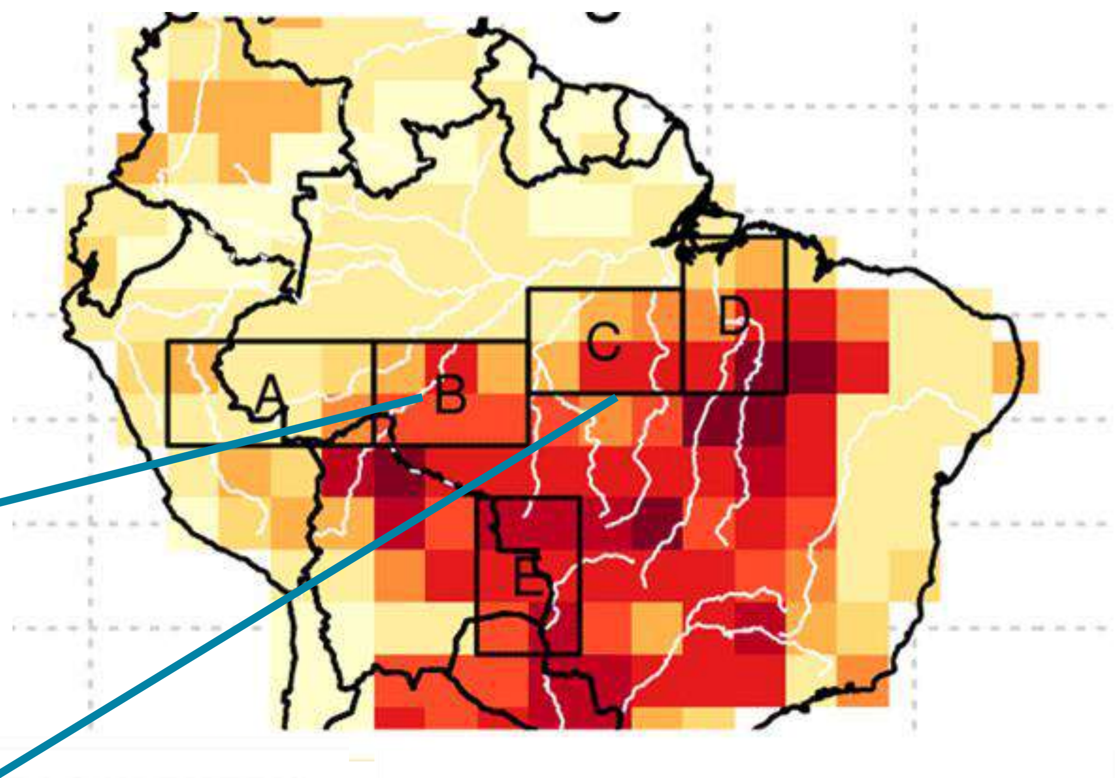
Most burning since MODIS started

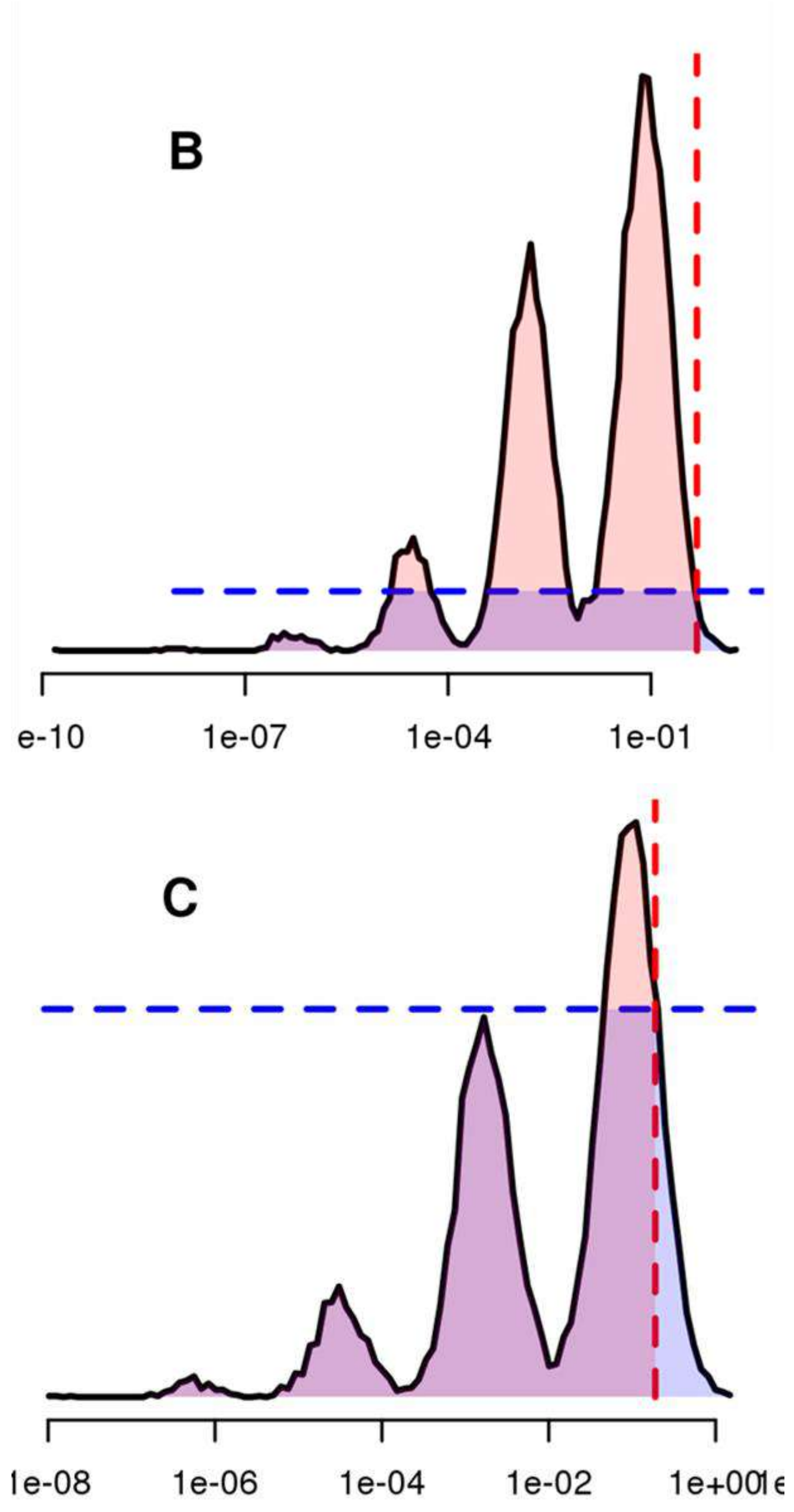
Meteorological conditions suggest drier west, wetter east

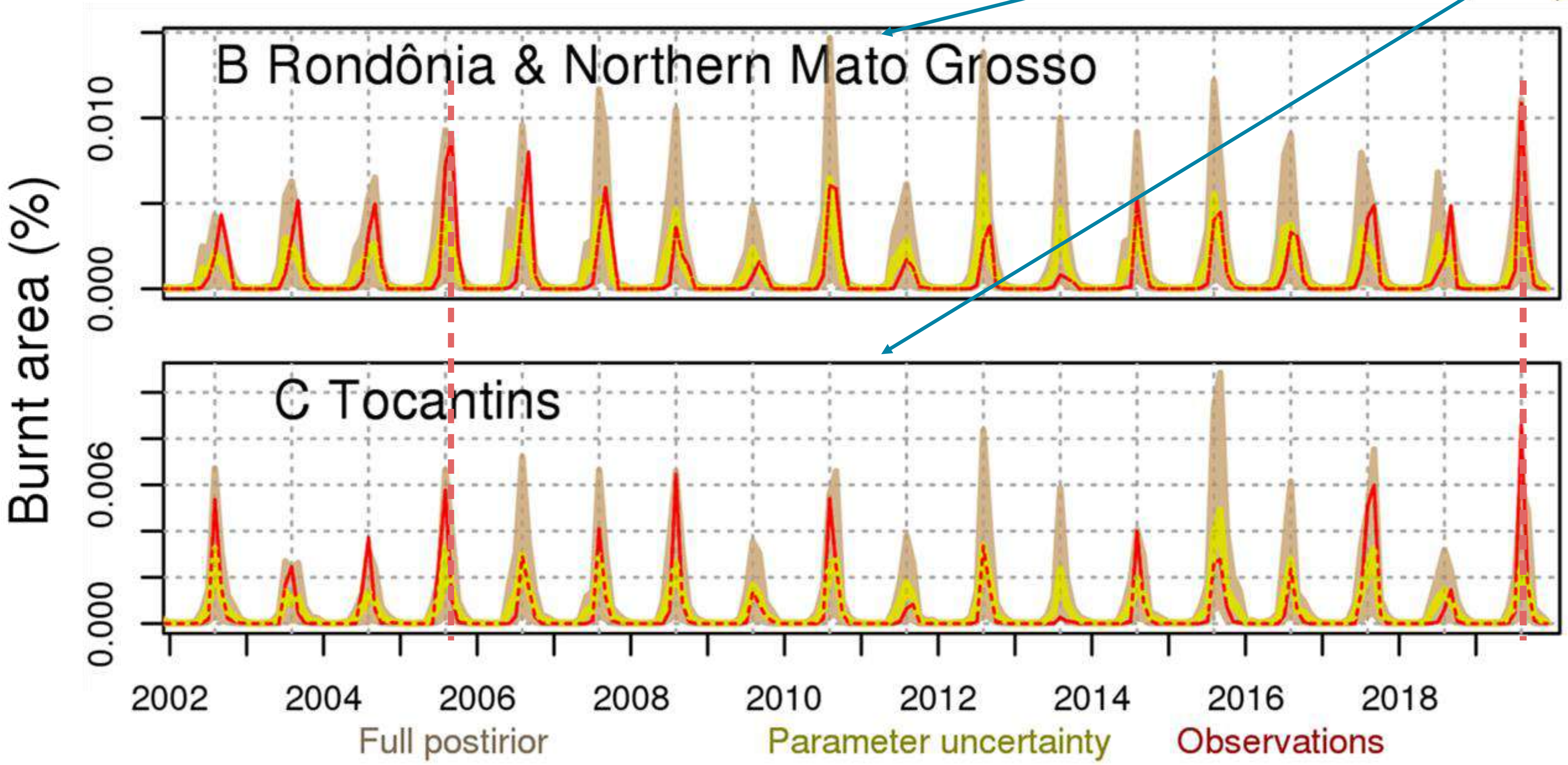

Bolivia
Brazil
DR Congo
Indonesia
Paraguay
Forest carbon (Pg)
Fire emissions (% forest carbon)
2012
2014
2016
2018
Tree carbon
Grass/Shrub carbon
DPM
Forest carbon loss
fire emissions

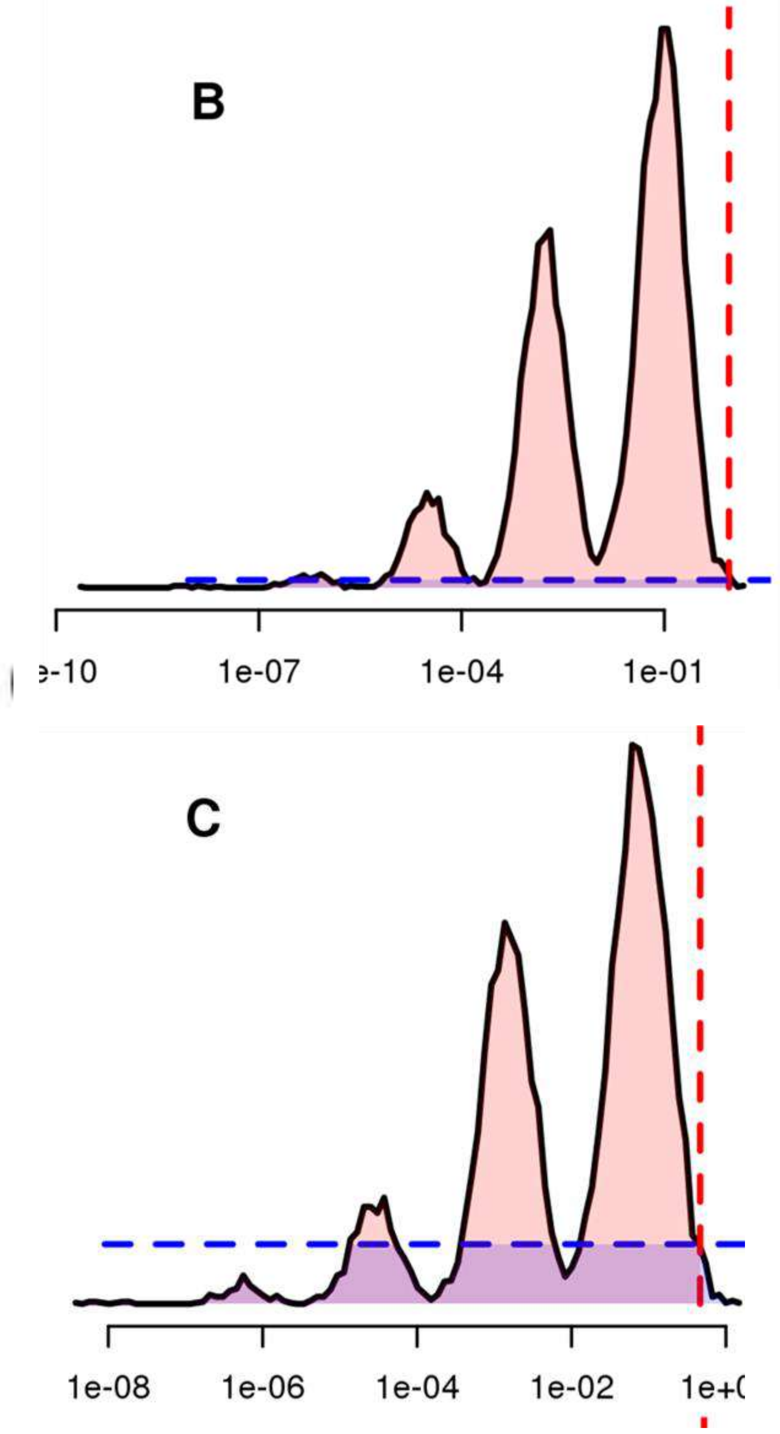
[redacted]

Example: Amazon burnt area





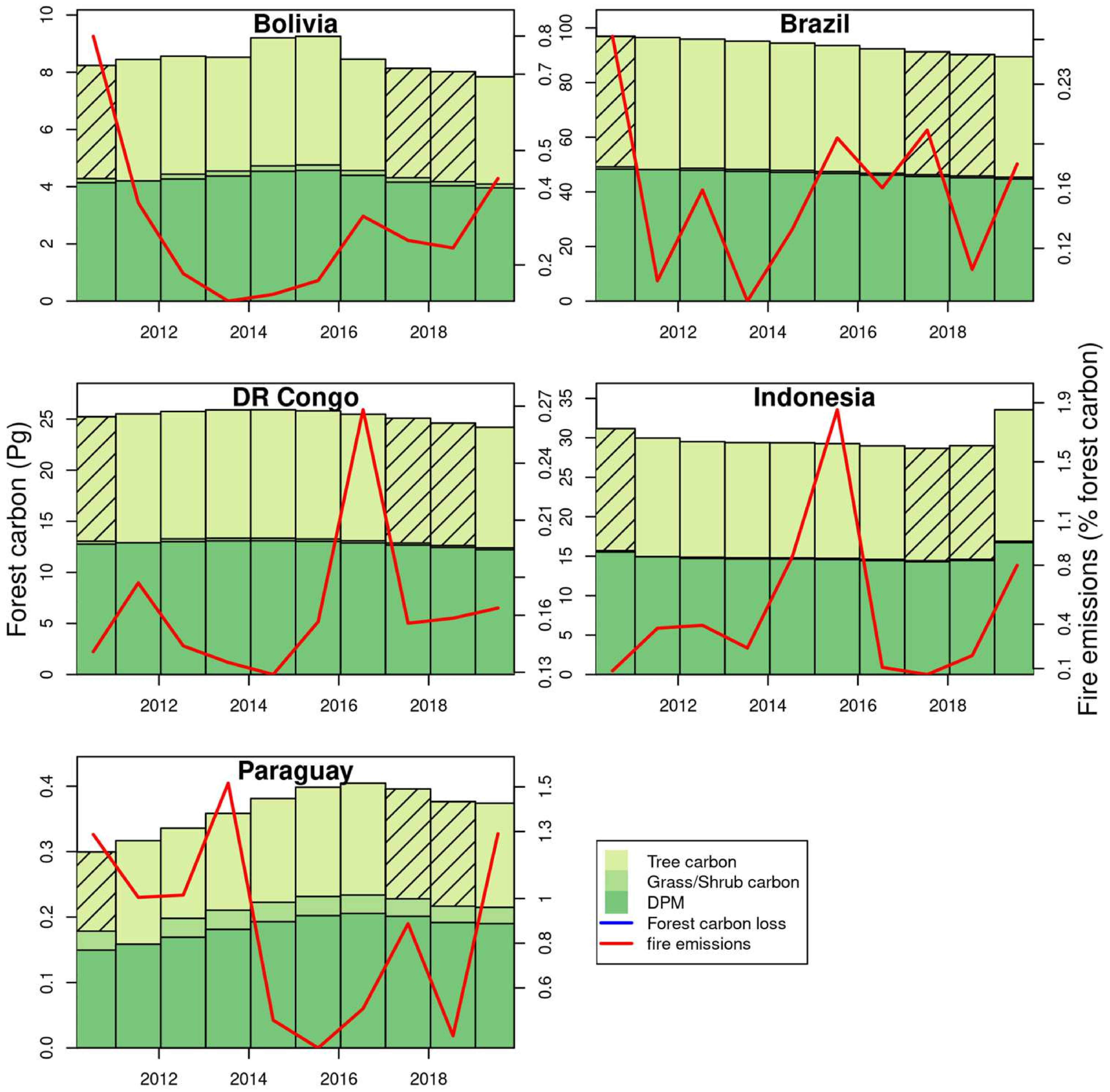




Kelley et al (2021) Technical note: Low meteorological influence found in 2019 Amazonia fires, doi:0.5194/bg-18-787-2021,

2) Historic carbon losses

Combining satellite observations and JULES-ES simulations to estimate forest carbon (green) and the % lost to fire each year (red)



Sullivan et al (in press) Spreading like Wildfire: The Rising Threat of Extraordinary Landscape Fires, UNEP RRA

INTENZ+ - global model

- Test the effectiveness of land-based climate mitigation strategies
- Monitor/verify ongoing carbon sequestration efforts.
- Trade-offs and co-benefits with food security and wildlife
- Resilience to future environmental impacts

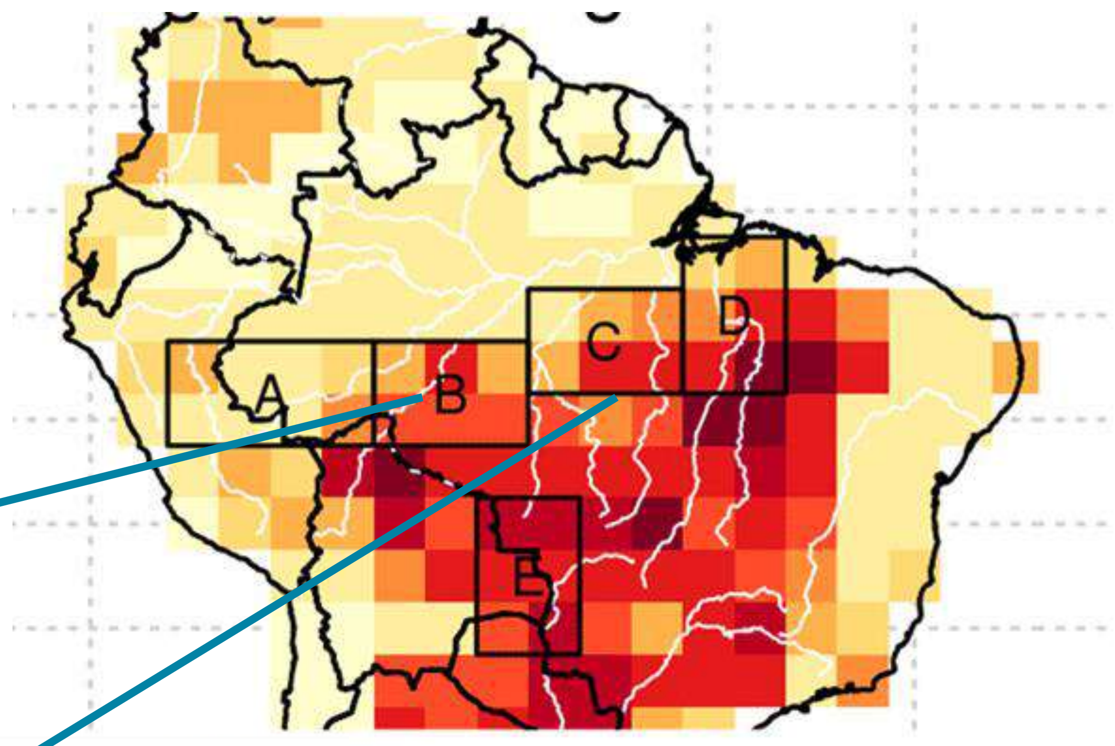
- Using JULES-ES ran with ISIMIP
- Developing optimization system to improve model/capture uncertainty.

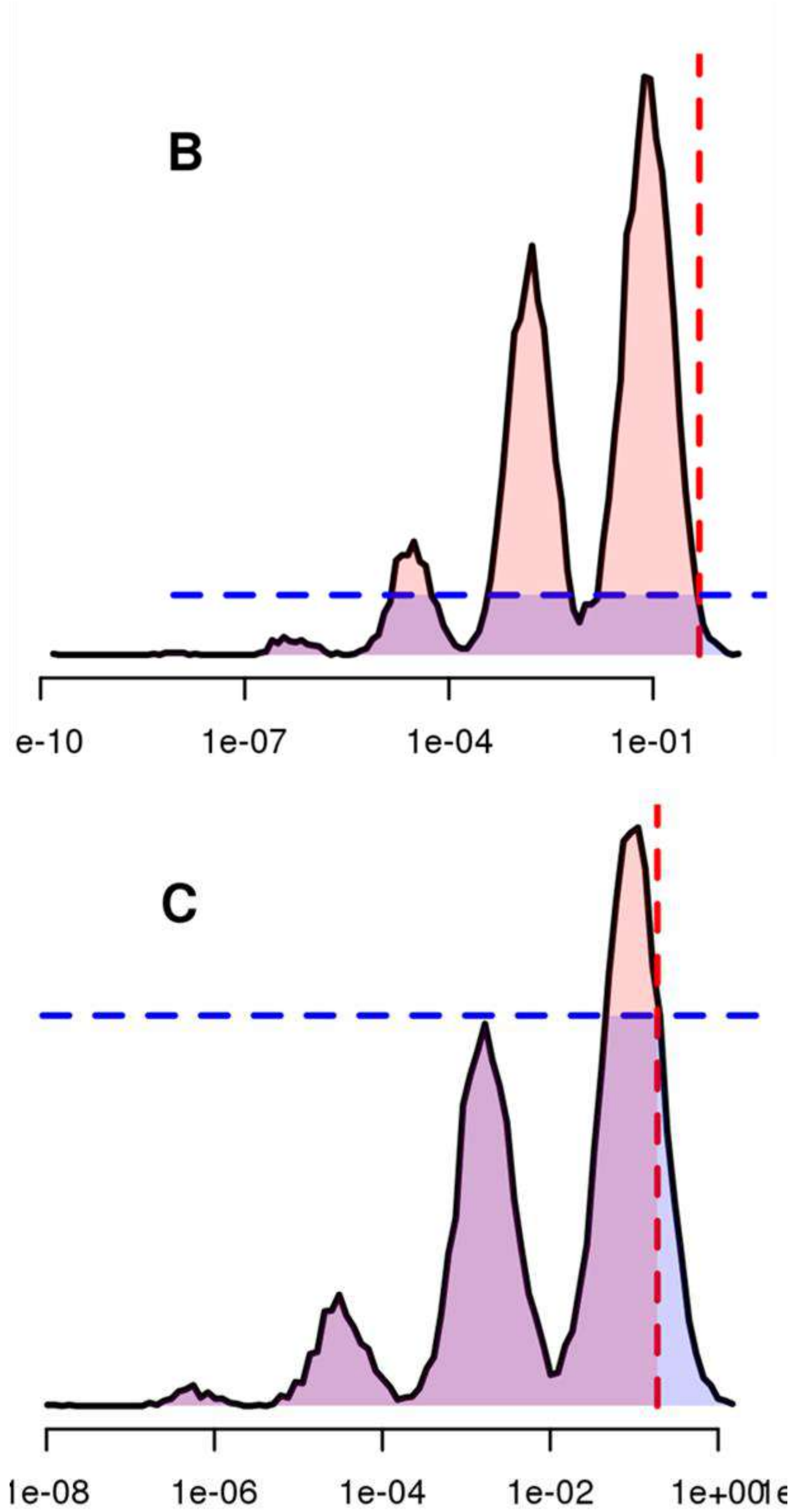
JULES-ES-ISIMIP

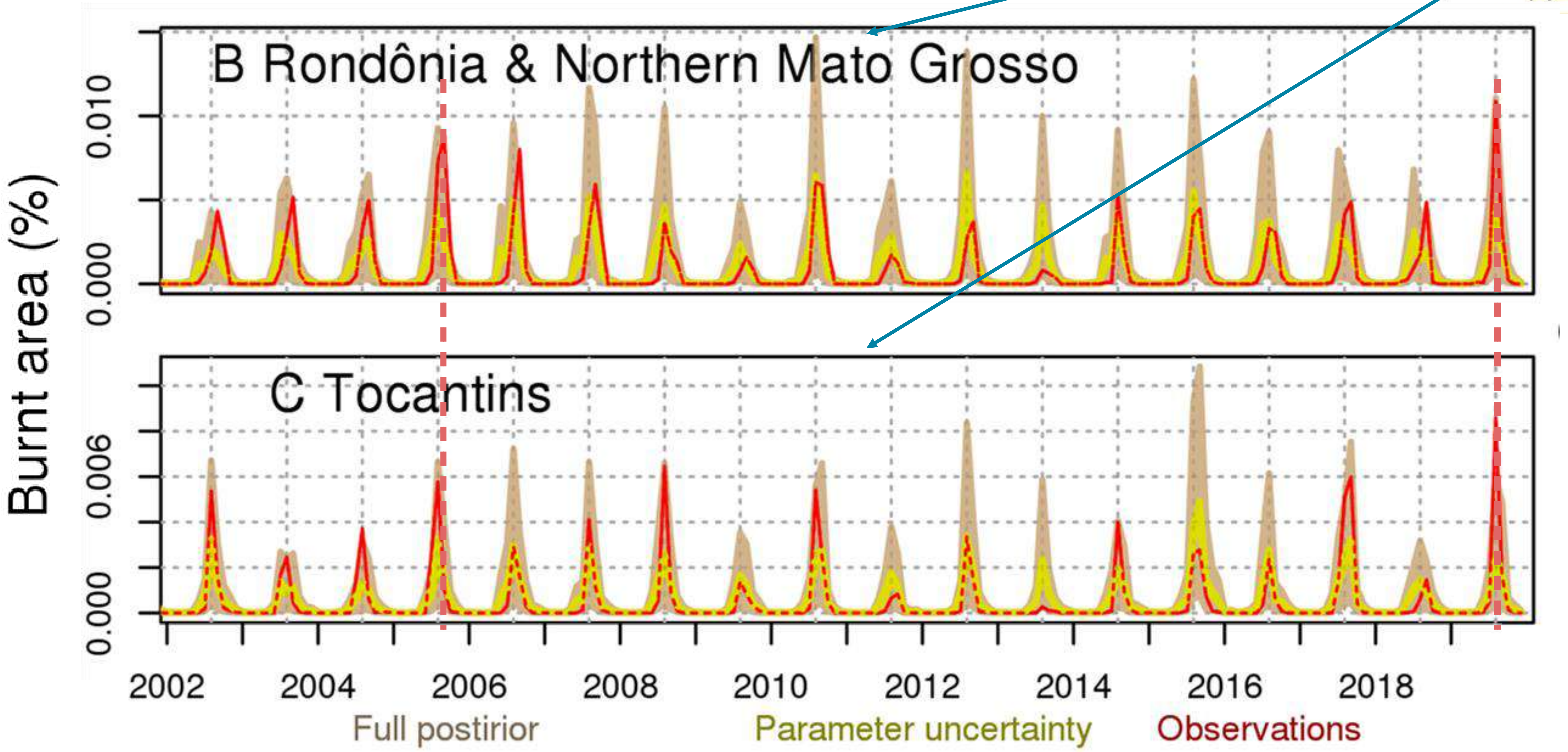
- 50km, daily carbon, water flux & storage
- Split between “plant types” (tree, shrub, grass, board/needle, evergreen/deciduous, c3/c4 photosynthesis, natural vs agricultural)
- Driven by observed climate to (almost) present day
- 4(5) Climate model projections 1860-2100, bias corrected to present day
- 2(4) future emissions scenario.

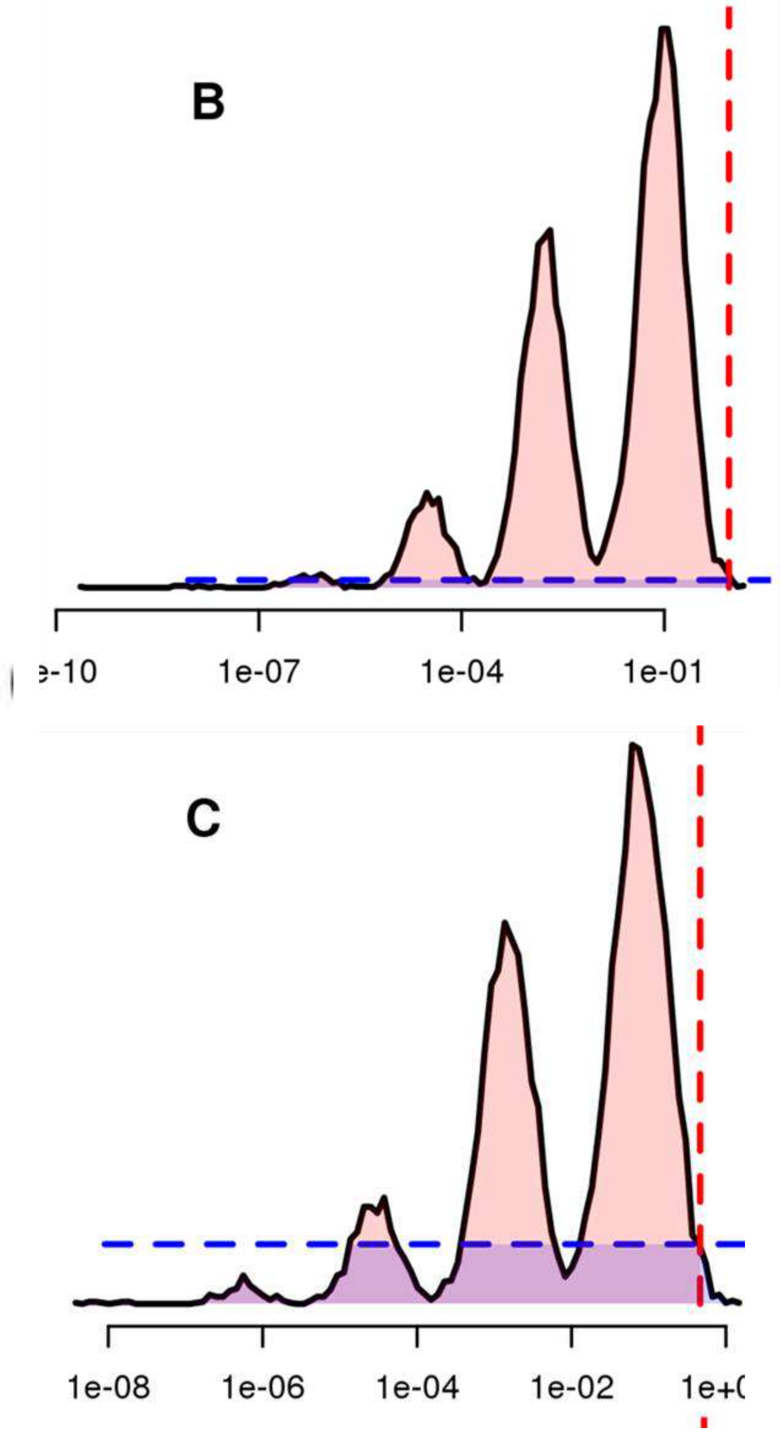
Mean Annual temp. (°C)
Forest aboveground carbon (kgC/m²)
Tree cover (%)
Belowground carbon (kgC/m²)
GFDL-ESM2M
HADGEM2-ES
IPSL-CM5A-LR
MIROC5
historic_TS_short
RCP2.6_TS
RCP6.0_TS
1960
1980
2000
2020
2040
2060
2080
2100
1960–1970
1995–2005
2040–2050
2089–2099
historic
RCP6.0
min
max
0
1
2
5
10
20
40
60
80
100

Example: Amazon burnt area



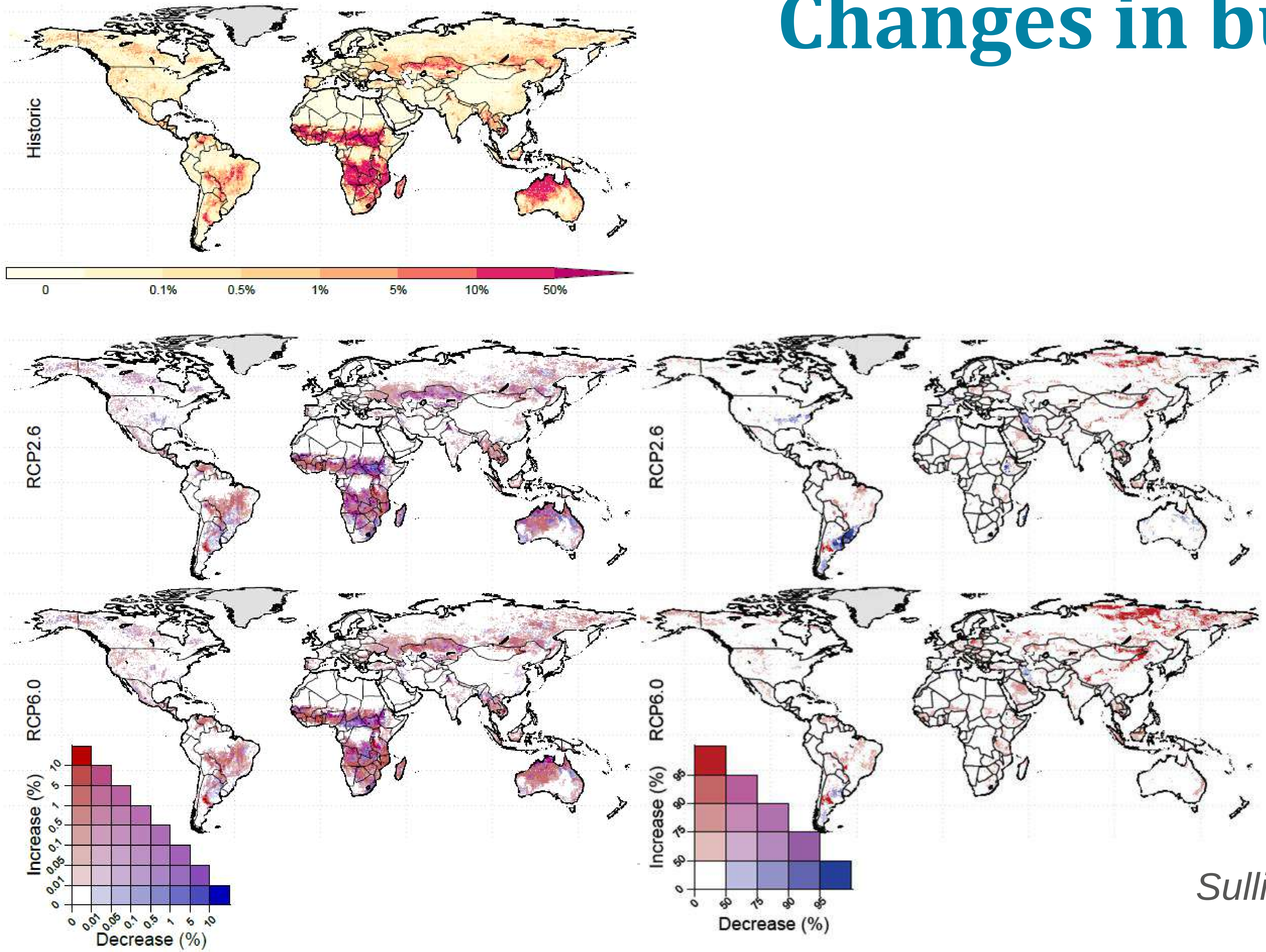






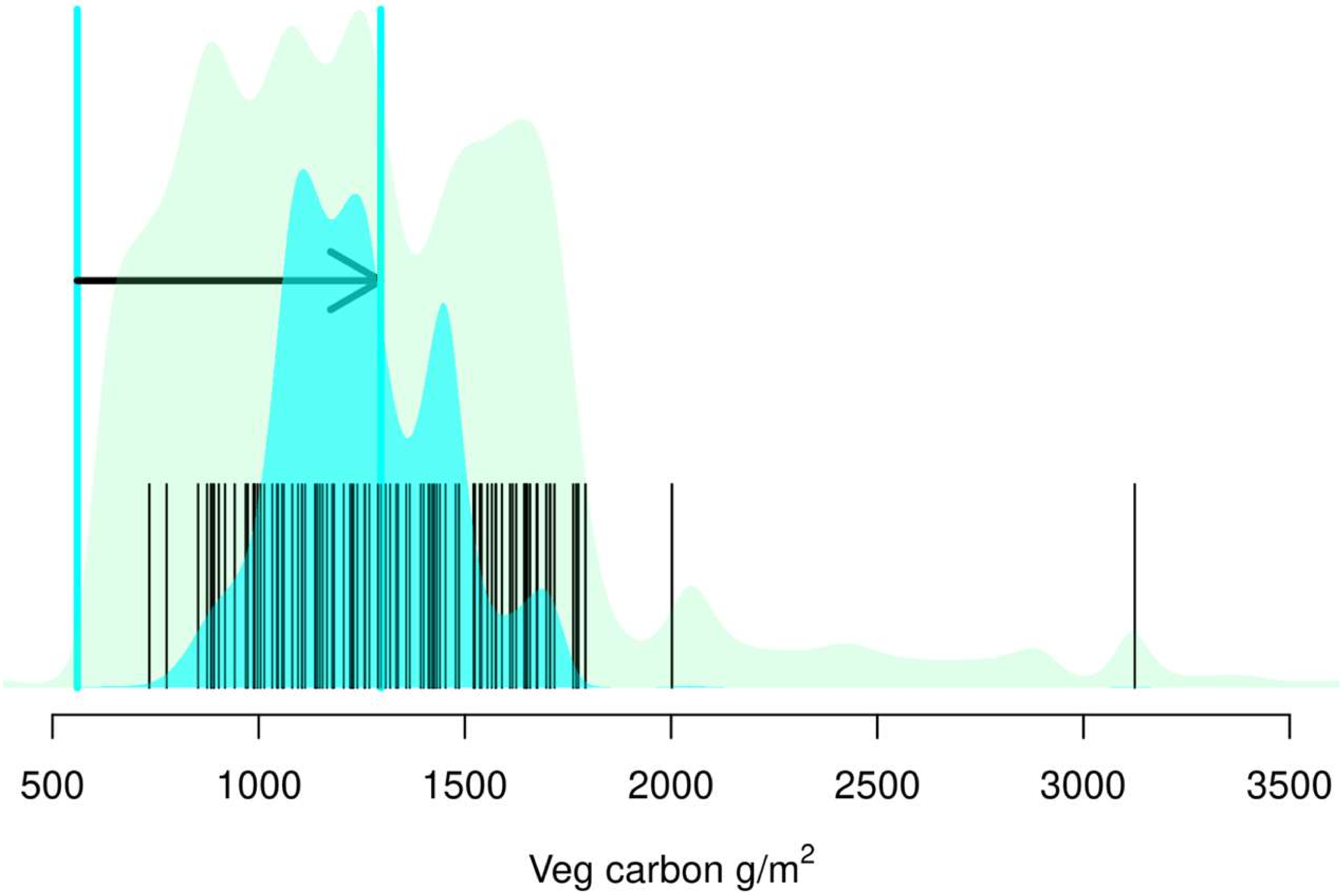
Kelley et al (2021) Technical note: Low meteorological influence found in 2019 Amazonia fires, doi:0.5194/bg-18-787-2021,

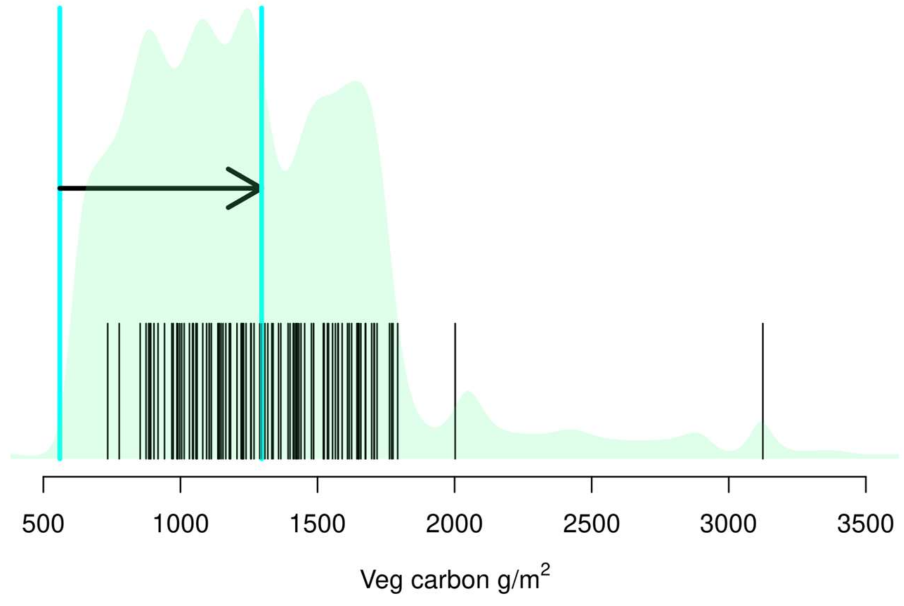
Changes in burnt area

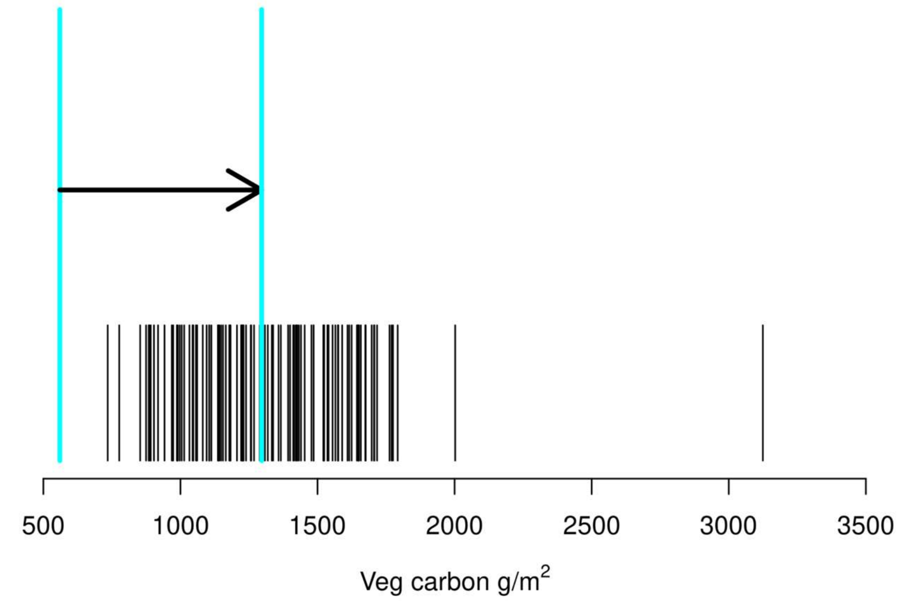


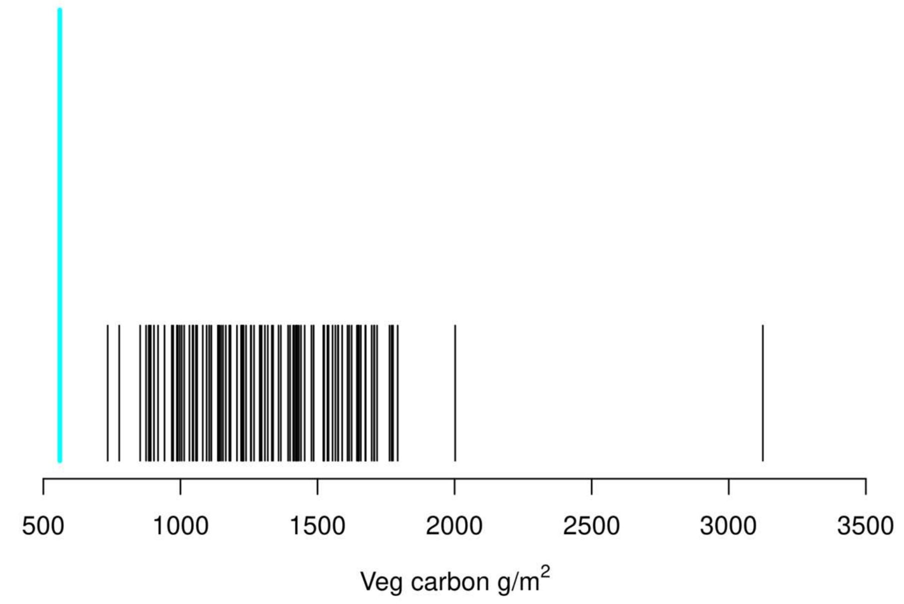
Sullivan et al. in review

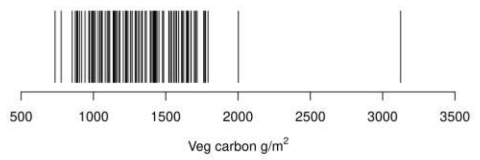
Absolute (old way) **Significant (new likelihood way)**


500
1000
1500
2000
2500
3000
3500
Veg carbon g/m2


500
1000
1500
2000
2500
3000
3500
Veg carbon g/m2

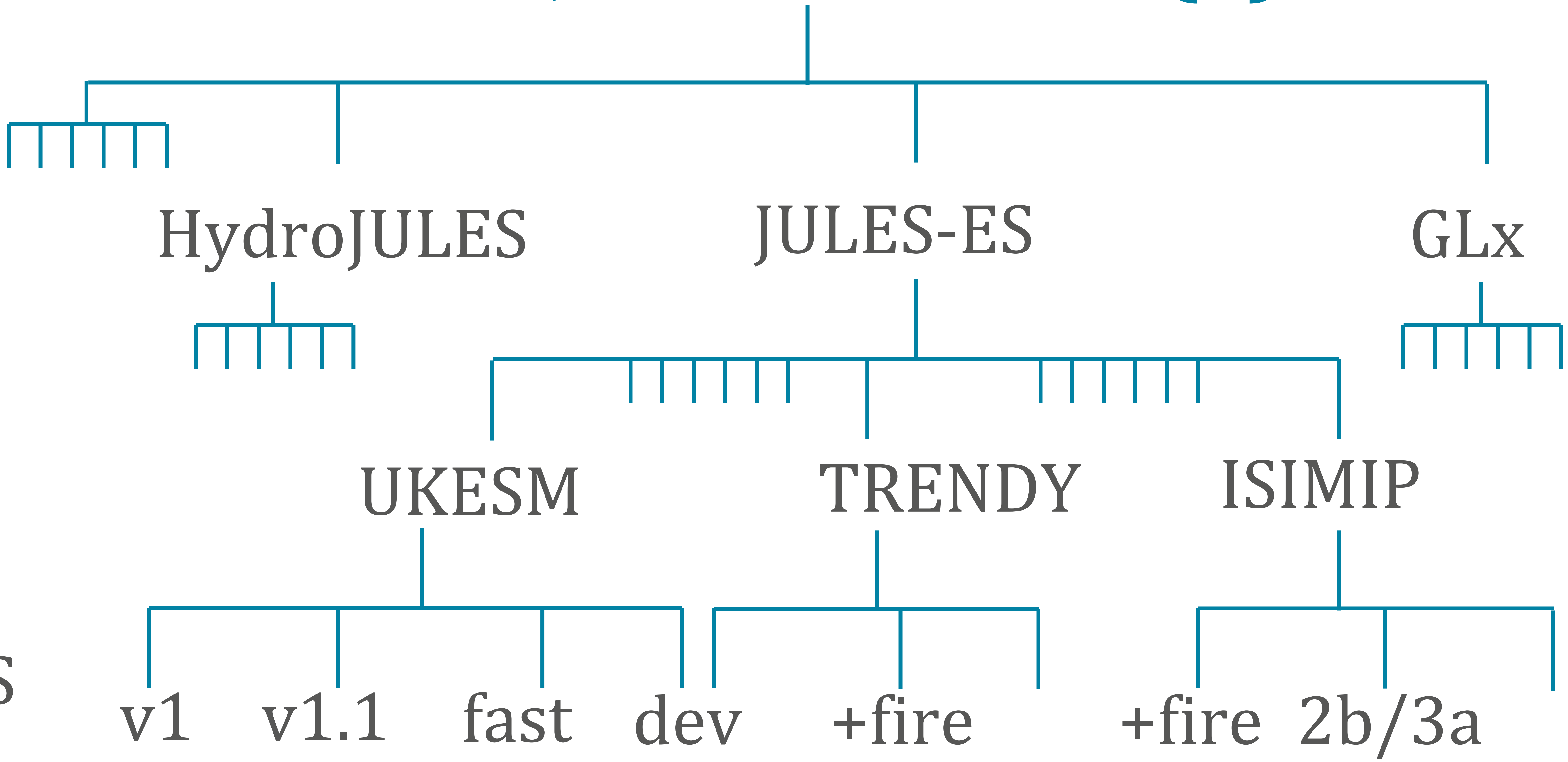

500
1000
1500
2000
2500
3000
3500
Veg carbon g/m2


500
1000
1500
2000
2500
3000
3500
Veg carbon g/m2



JULES model(s)

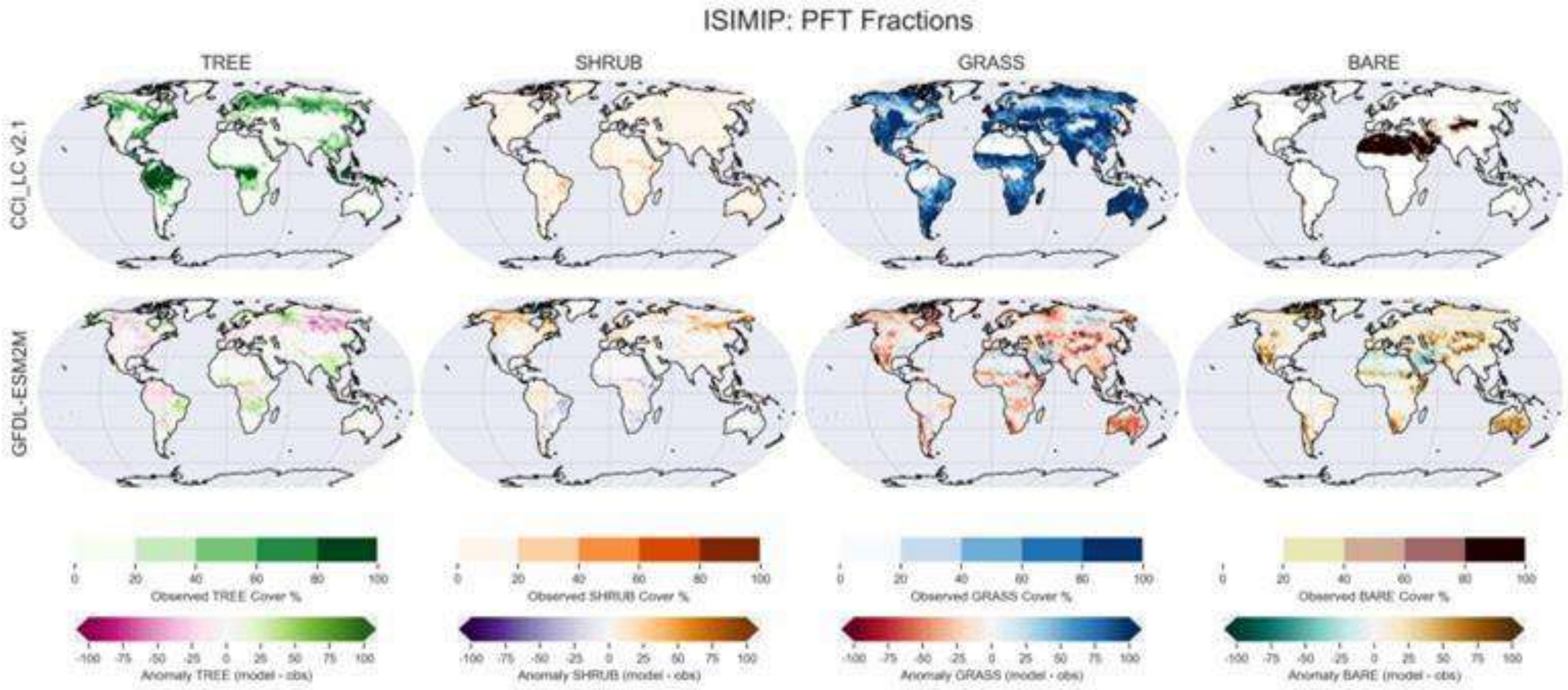
- There isn't ***a*** JULES
- Don't assume we don't simulate something based on a JULES configuration you've used before
- If your unsure what JULES config to use, ask



What JULES-ES does

- Runs globally (though mostly showing tropics today)
- Historic & future veg composition/carbon/hydrological fluxes, stores:
  - interactive through UKESM
  - Using multiple climate models with ISIMIP
- Combining JULES with observations for impact assessment.
- Note: plots are a mix of JULES-ES-TRENDY, ISIMIP and UKESM. But most can be done in **ISIMIP**

Competing plants types (JULES-ISIMIP)



Trop. BL

Temp. BL

Dec BL

EG NL

Dec NL

EG shrub

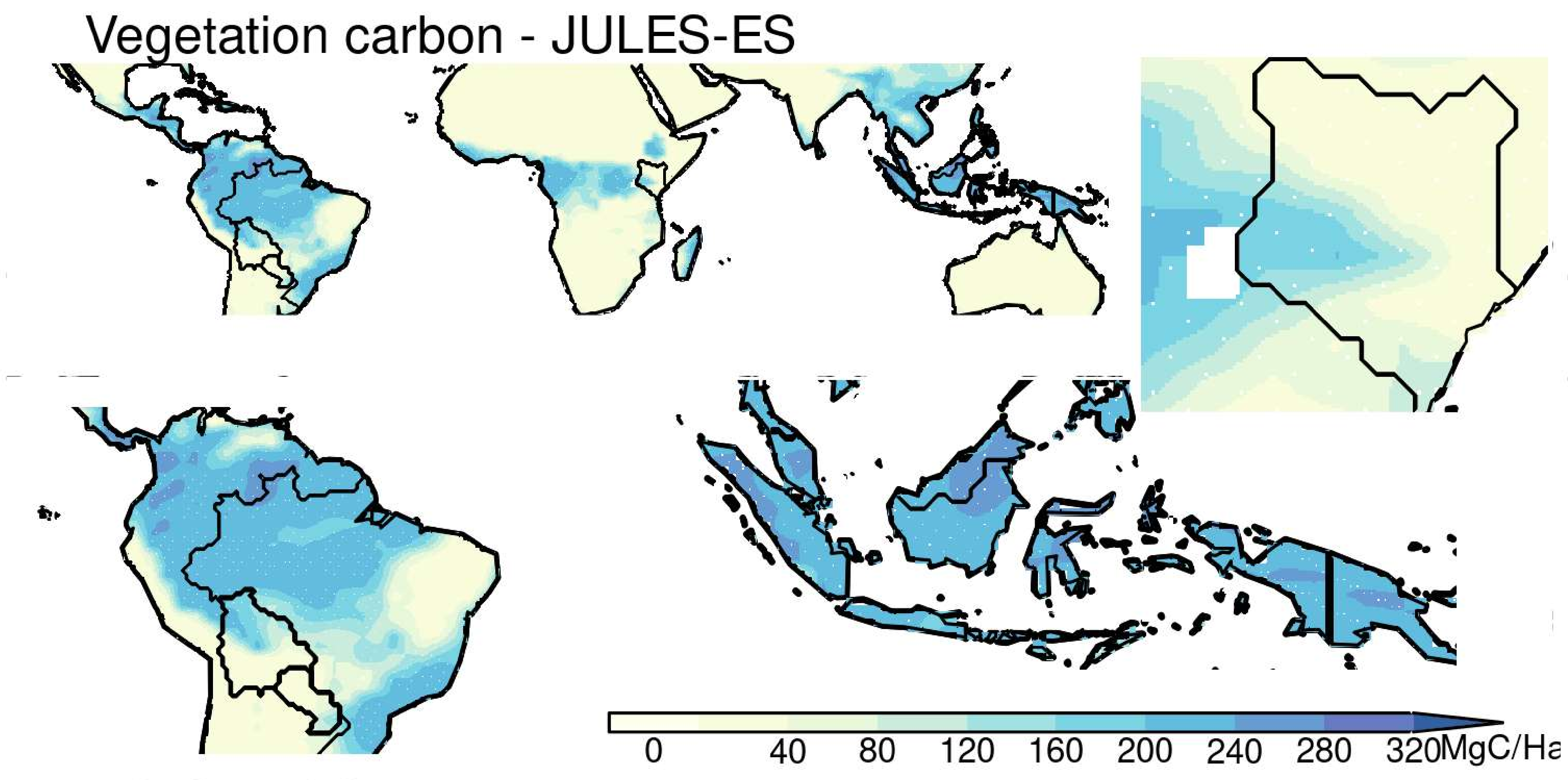
DEC shrub

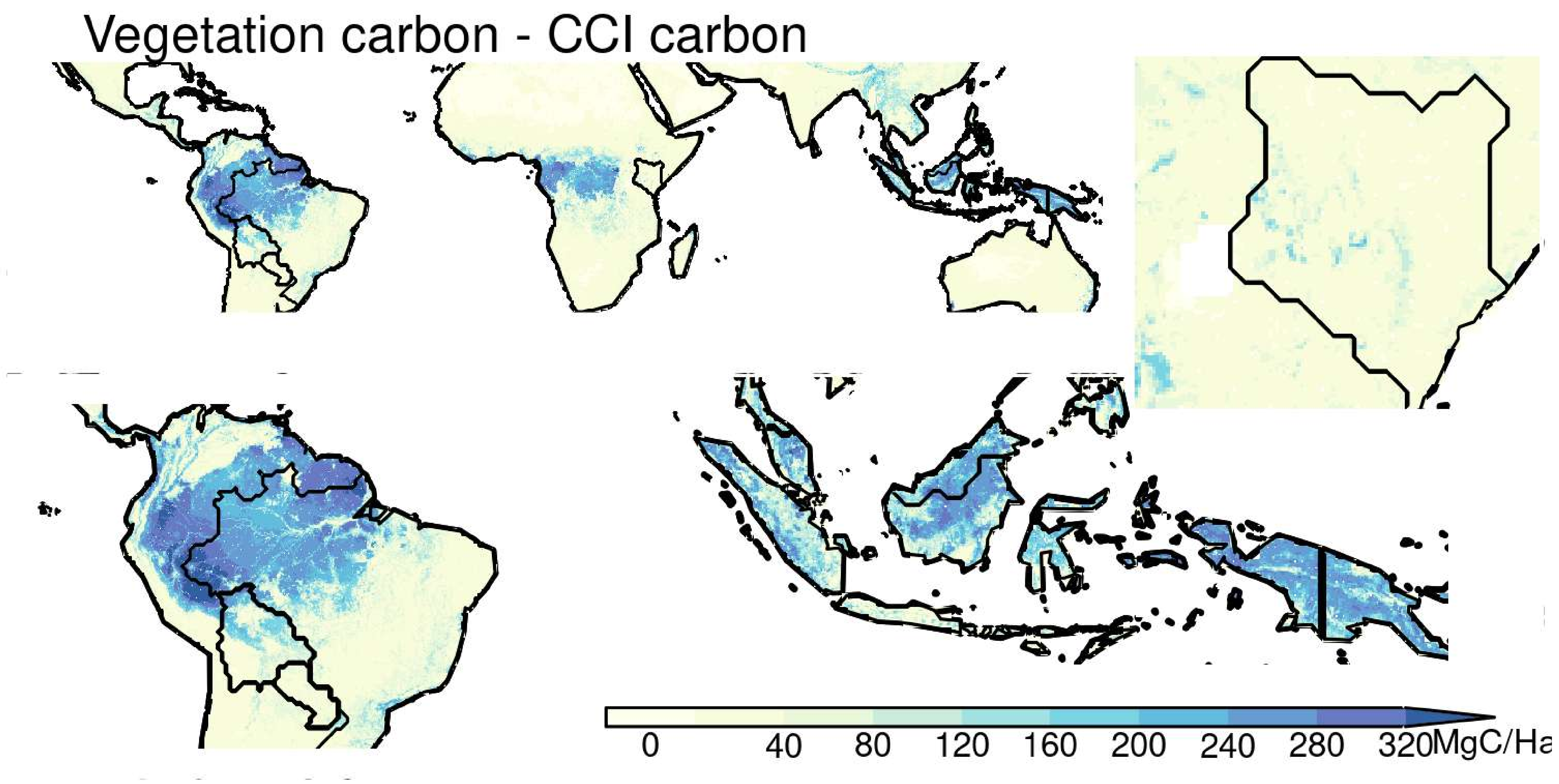
C3, C4 grass

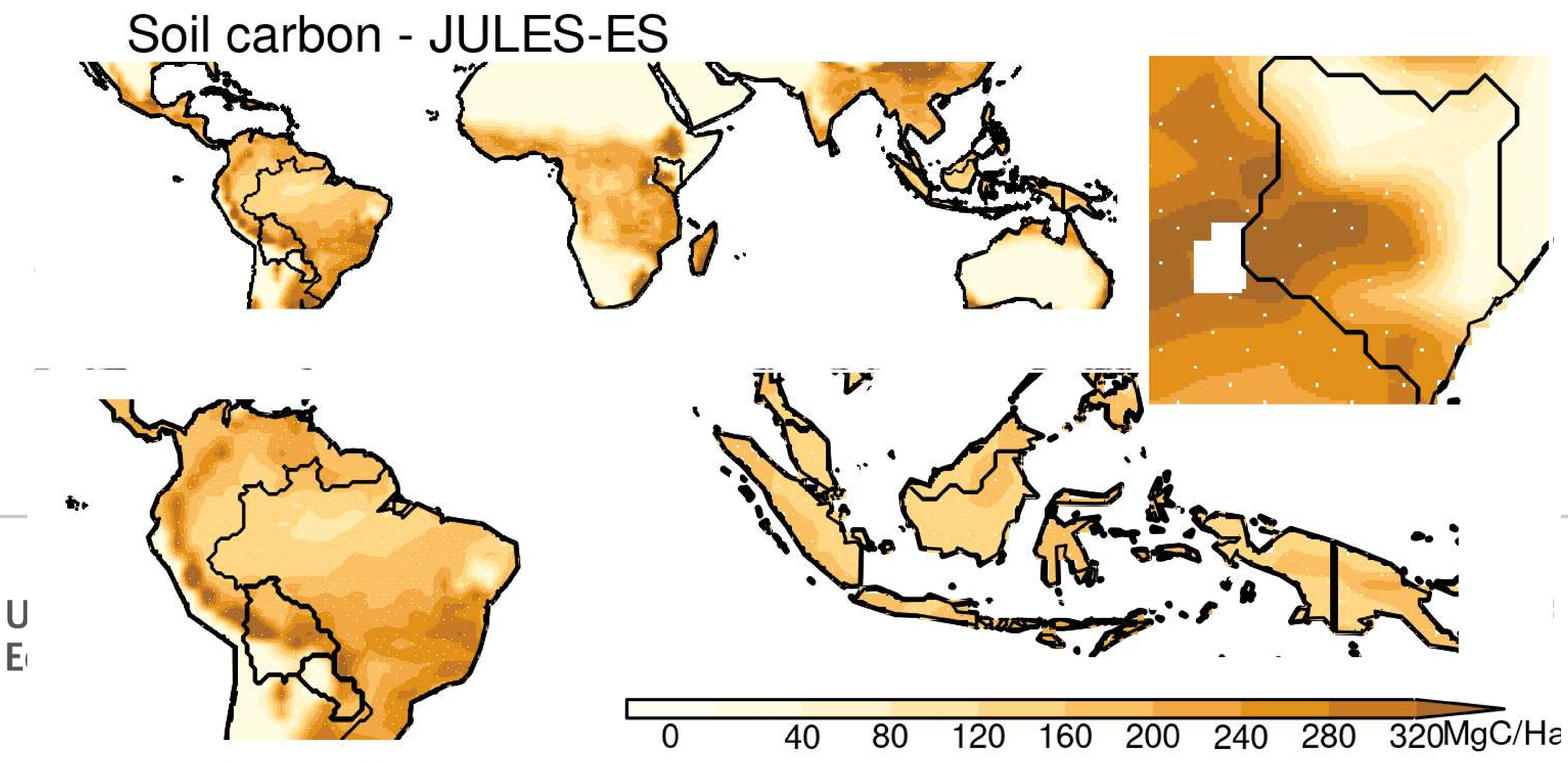
Crop & pas

UK Centre for Ecology & Hydrology

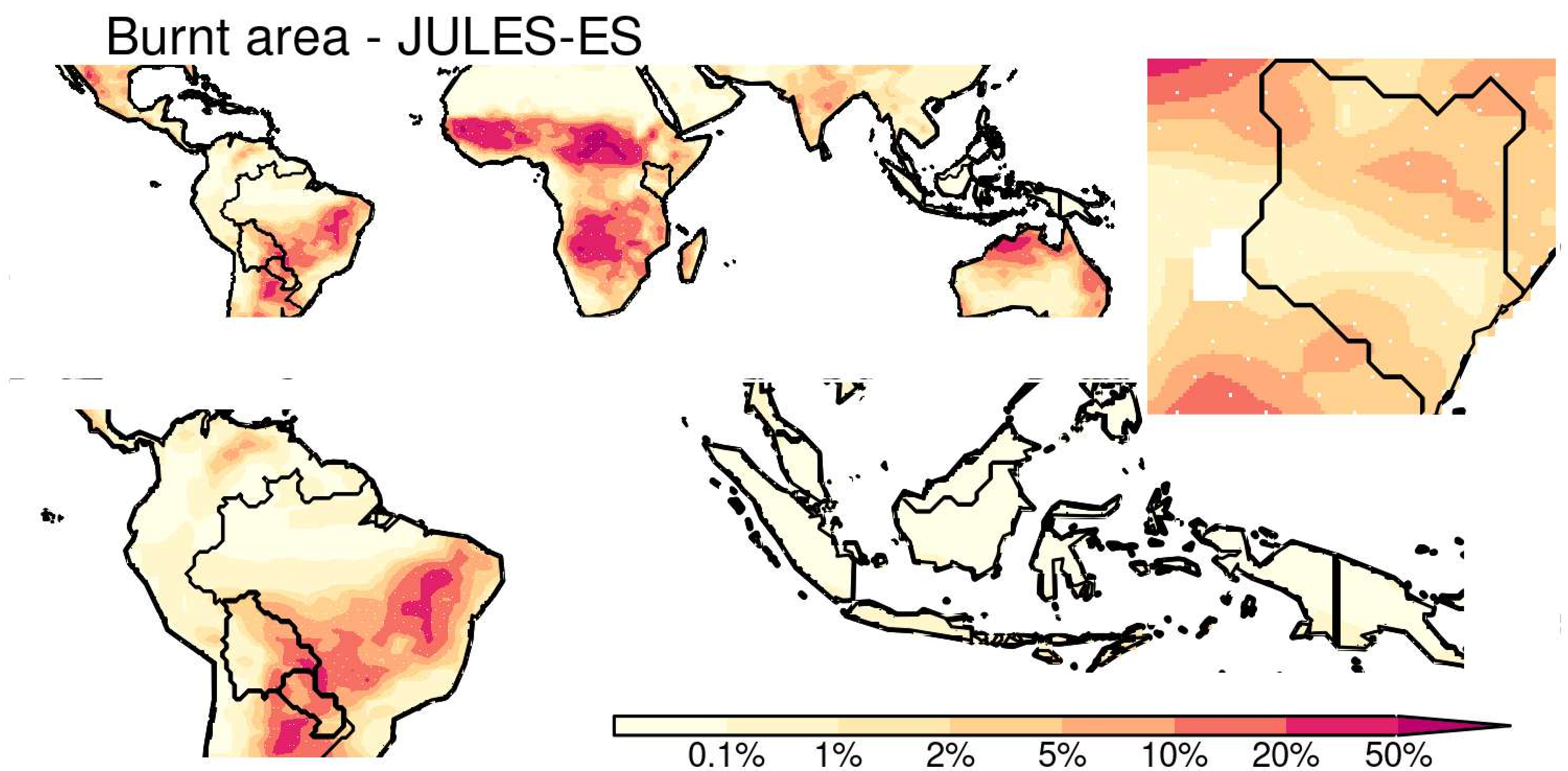
Historic gridded/temporal carbon stores (TRENDY)

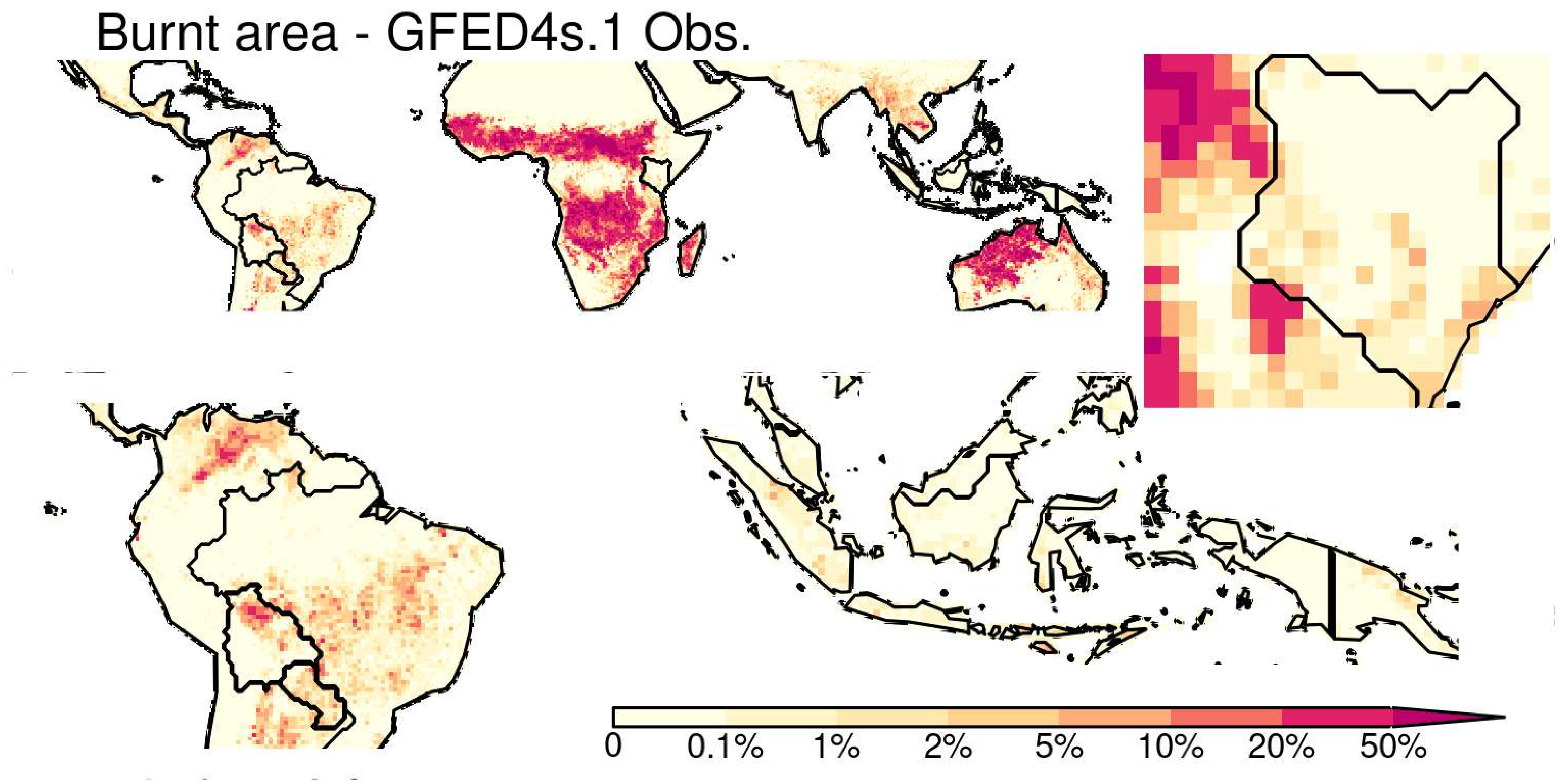


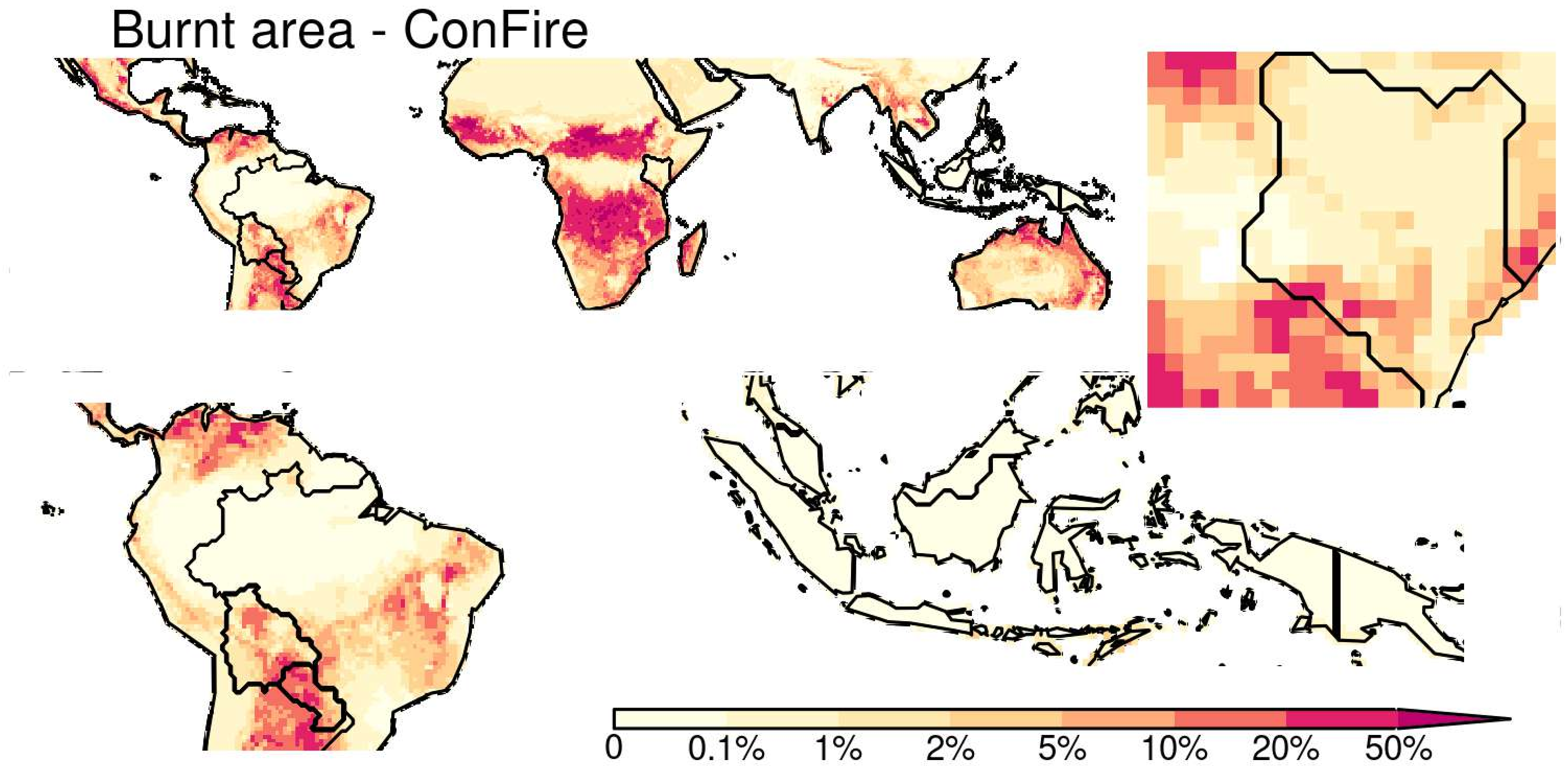




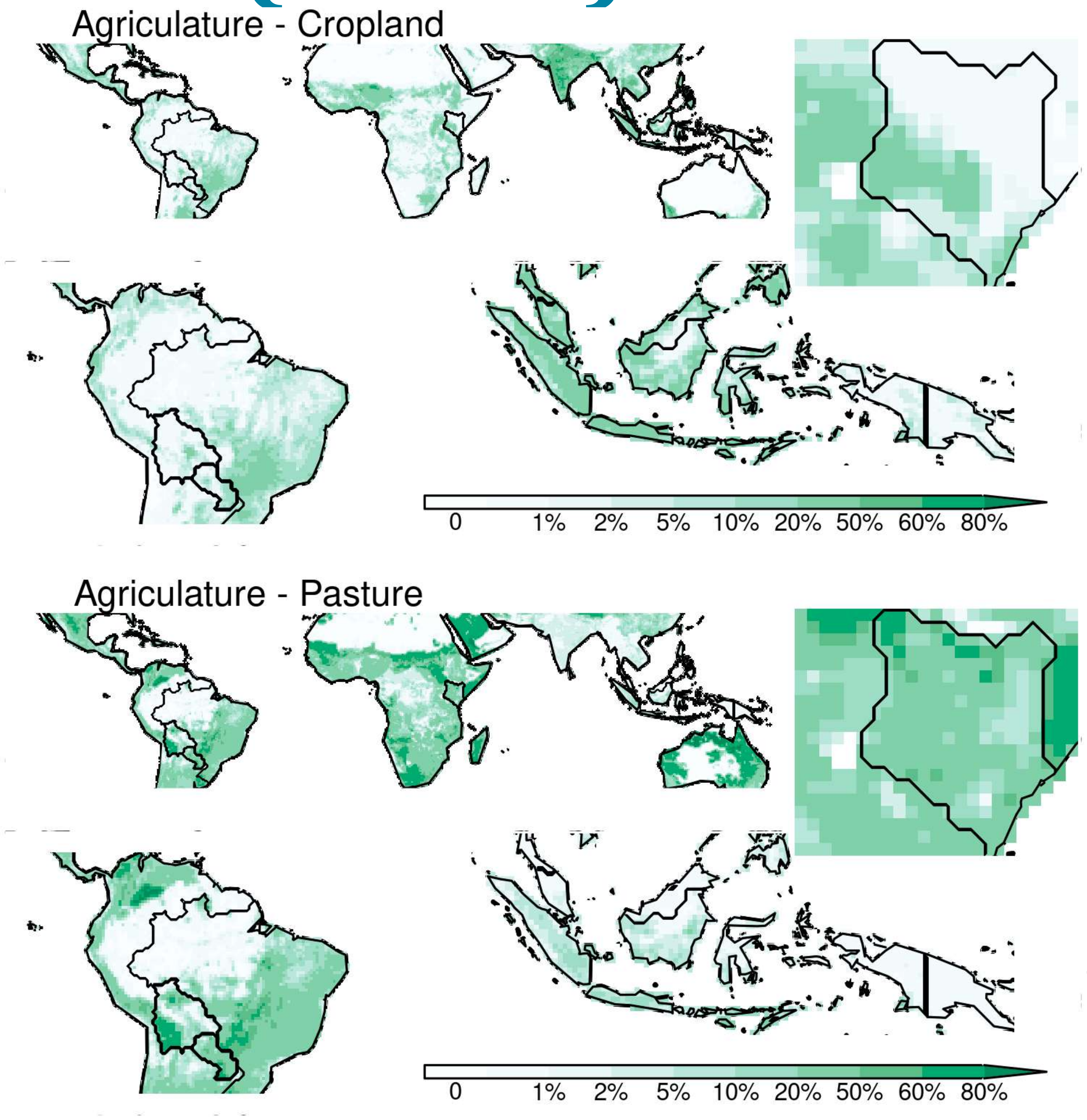
Historic gridded/temporal burnt area (TRENDY, ConFire)

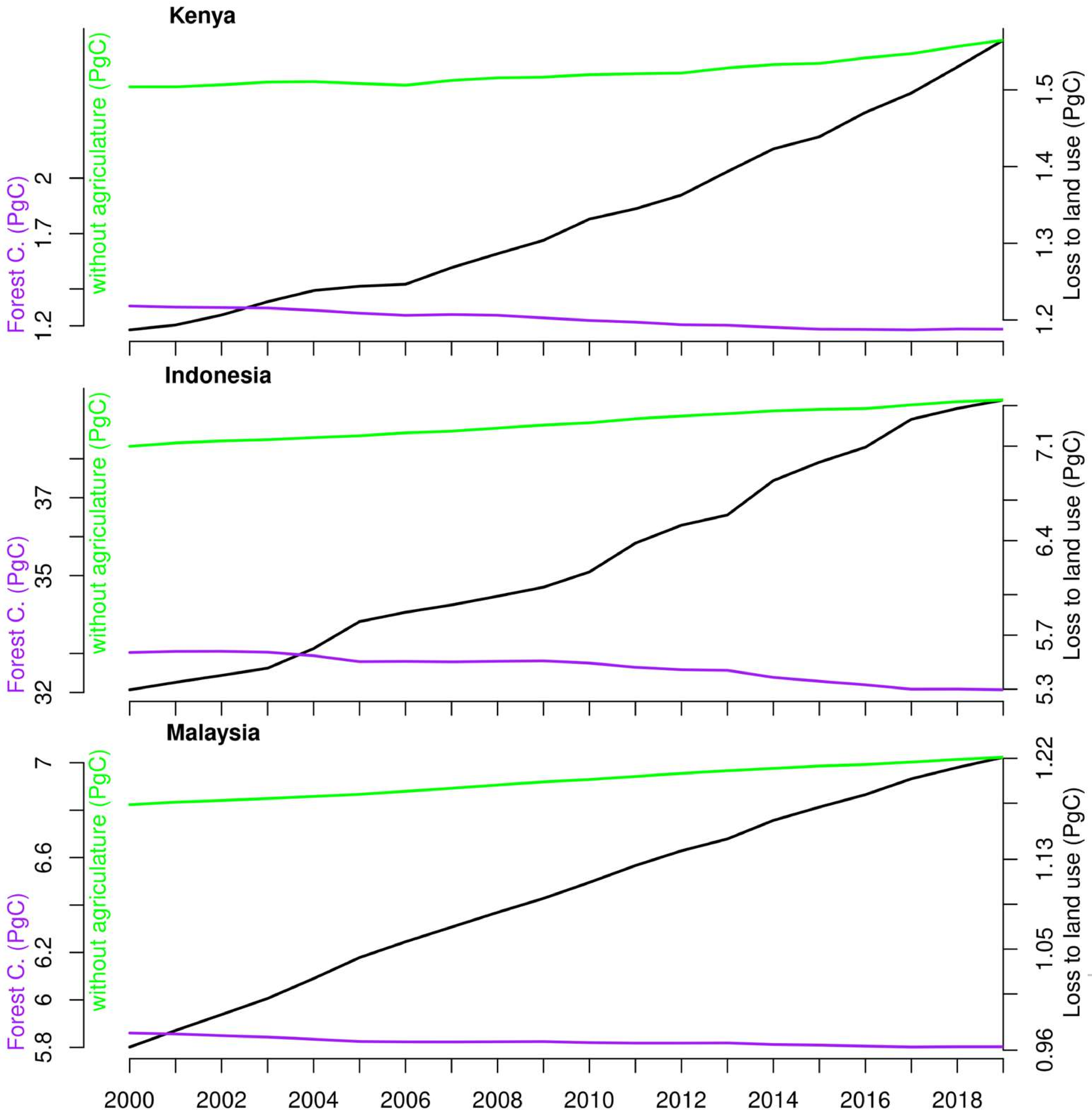




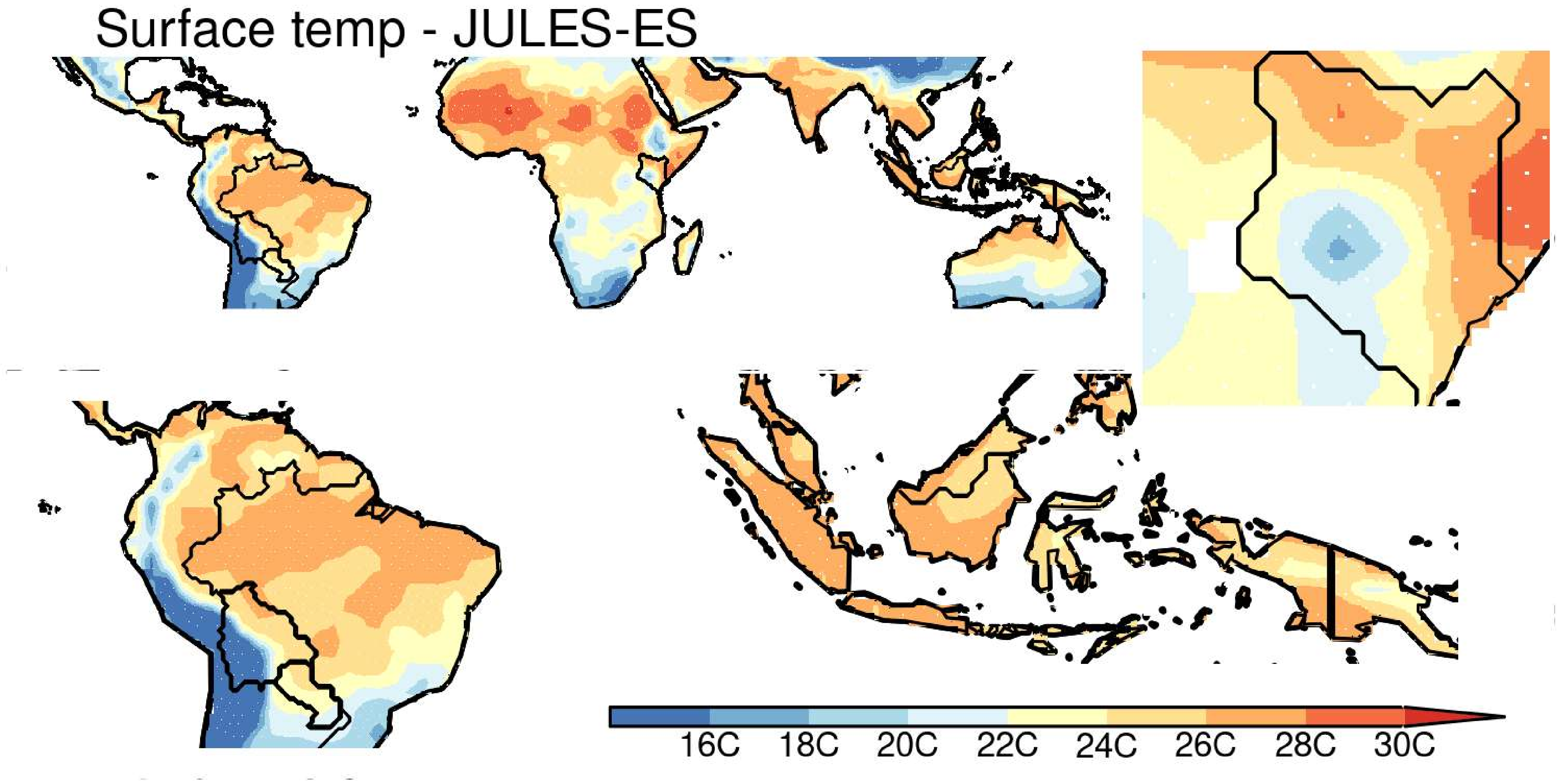


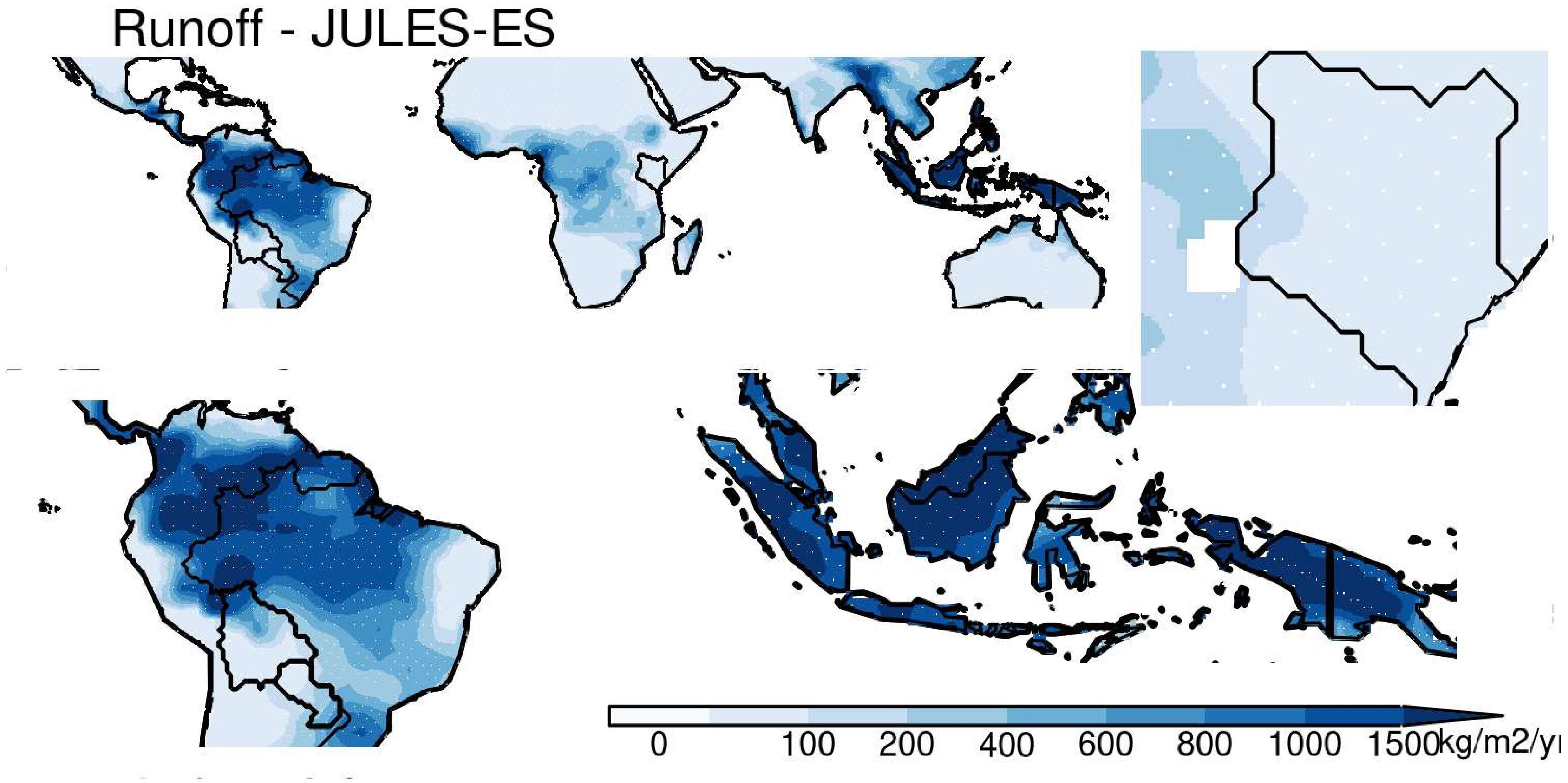
Land use impacts (HYDE)

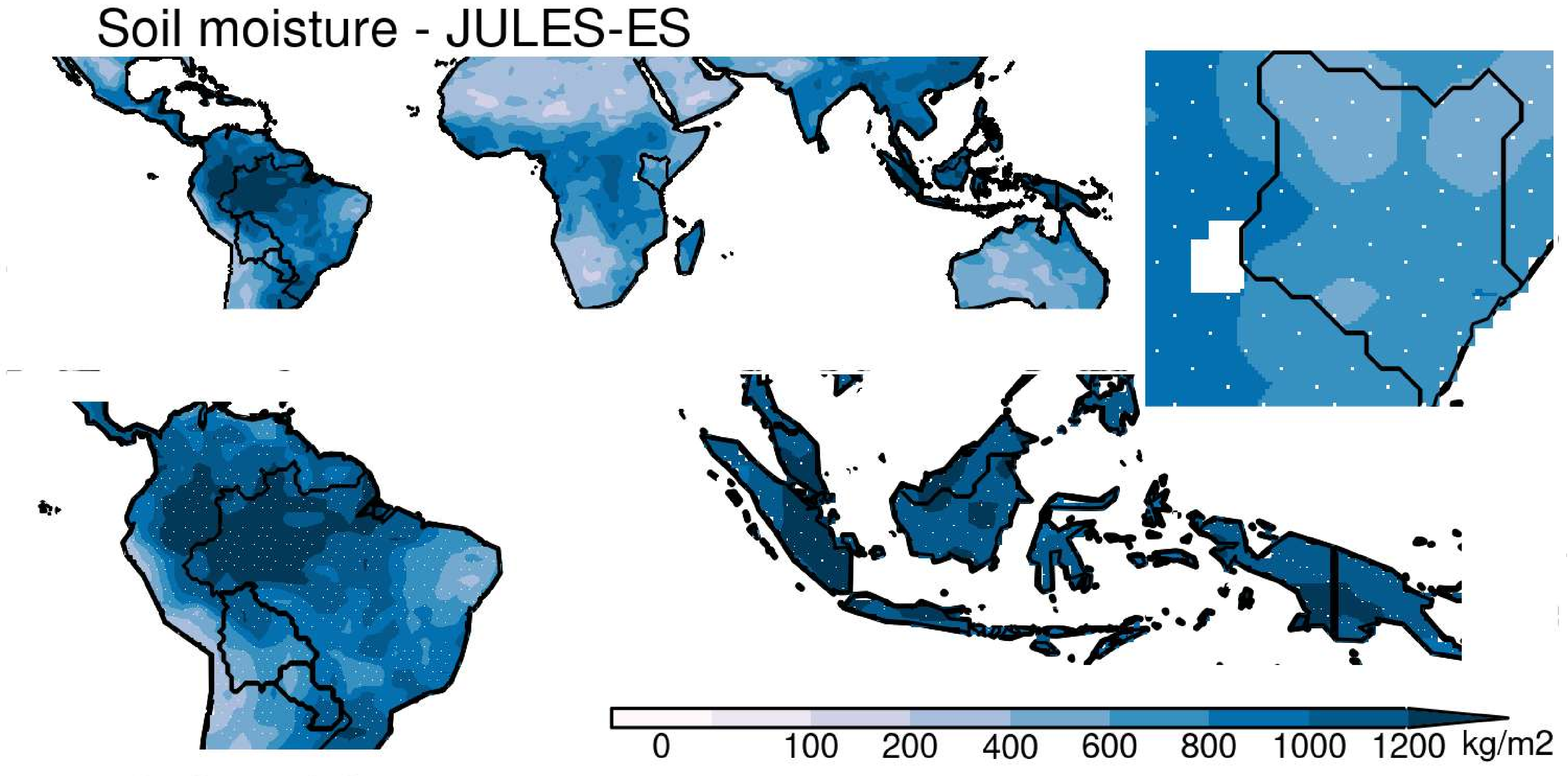




Historic gridded/temporal environment







Historic gridded/temporal environment

Relationships between carbon flux/environmental conditions

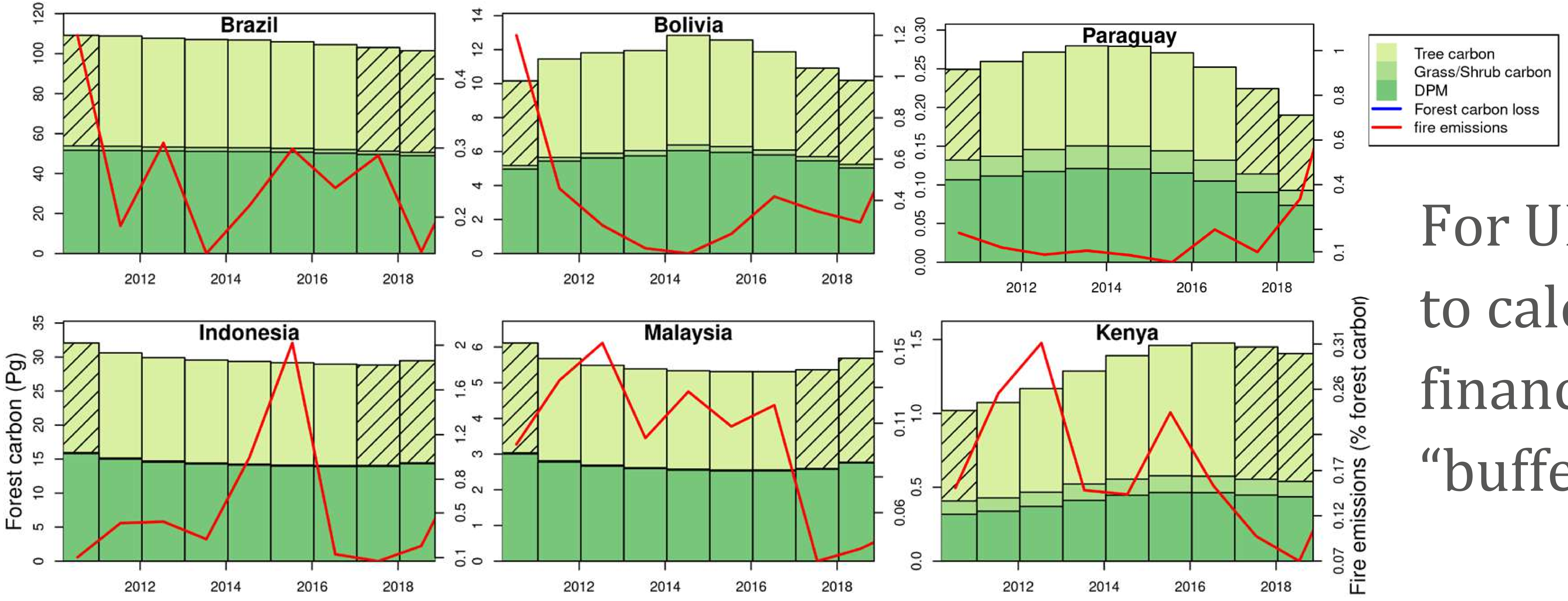
3) Future carbon risk from fire

JULES-ES “gaps” (that we’re working on)

- There are biases in the model
- Uncertainty in Land Surface Science
- Uncertainty in future emissions and climate response.
- Using this uncertainty for impacts projections.

Problem 1: models biases

Carbon finance buffer - bias corrected forest carbon



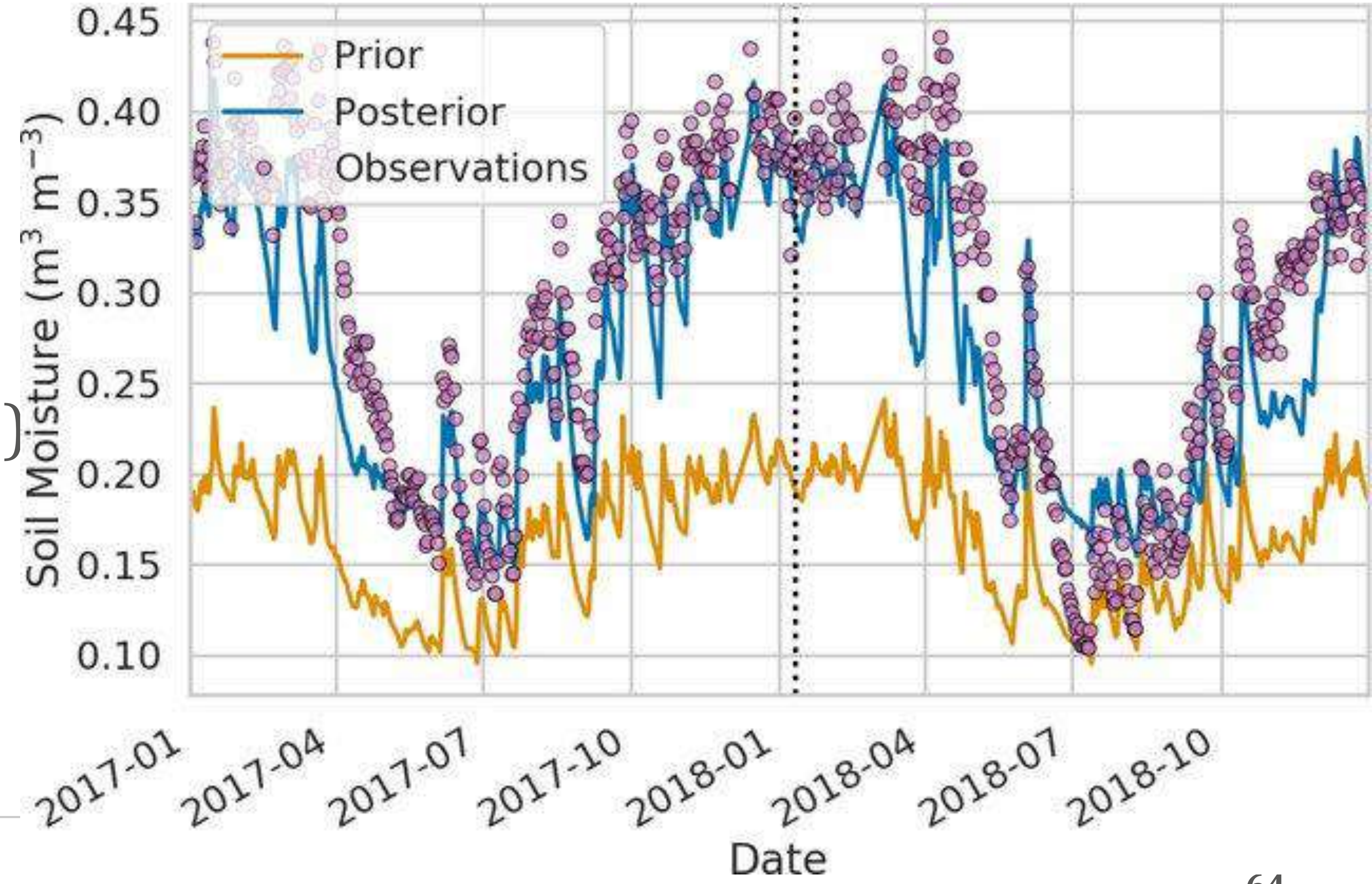
For UNEP to calculate finance "buffer"

Assimilating soil moisture observations

For a UK site

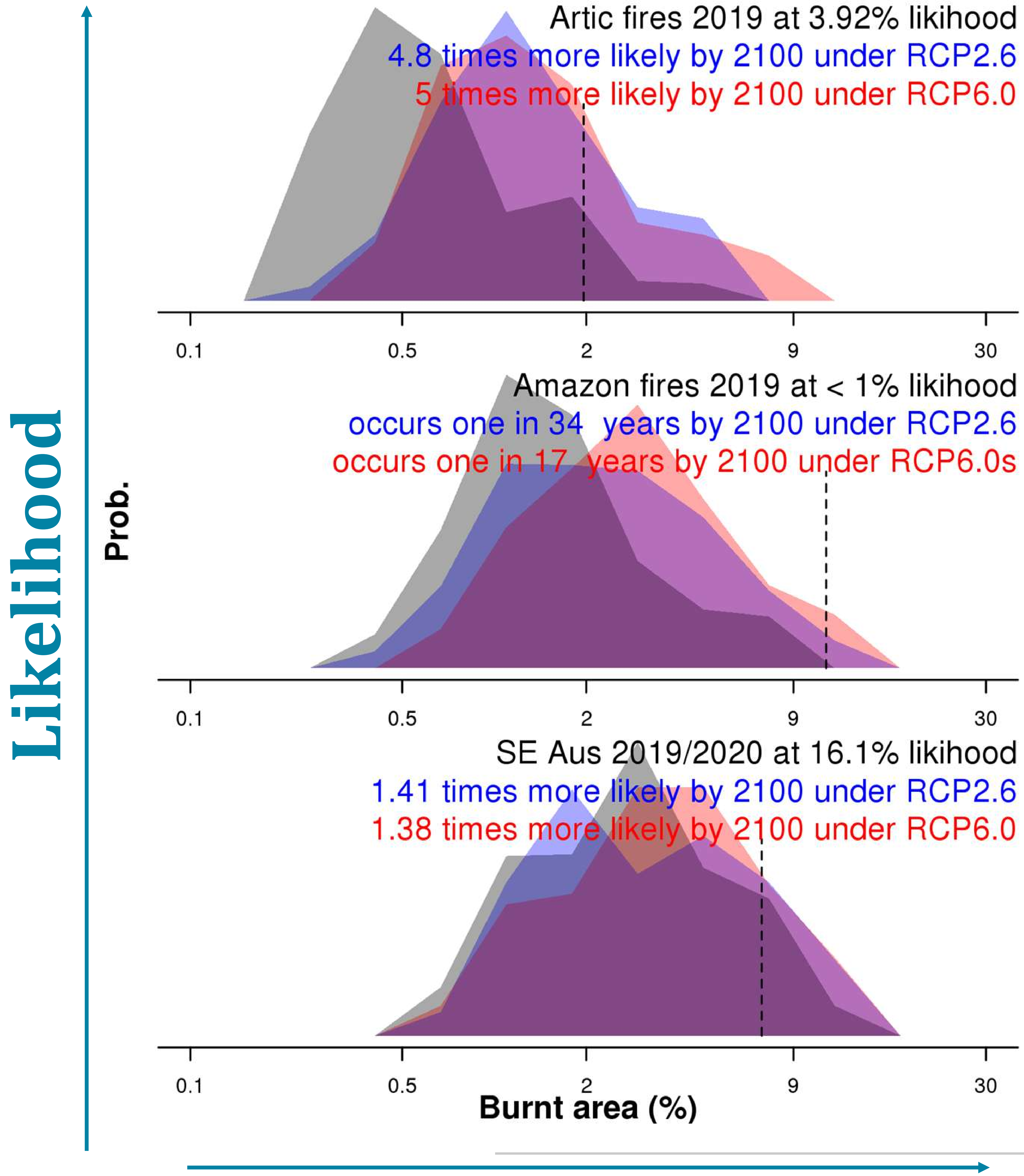
Optimizing pedotransfer

From Liz Cooper
(Cooper et al. HESS 2021)



UK Centre for
Ecology & Hydrology

Problem 2: Obs. & land surface science is uncertain



Proxy for impact

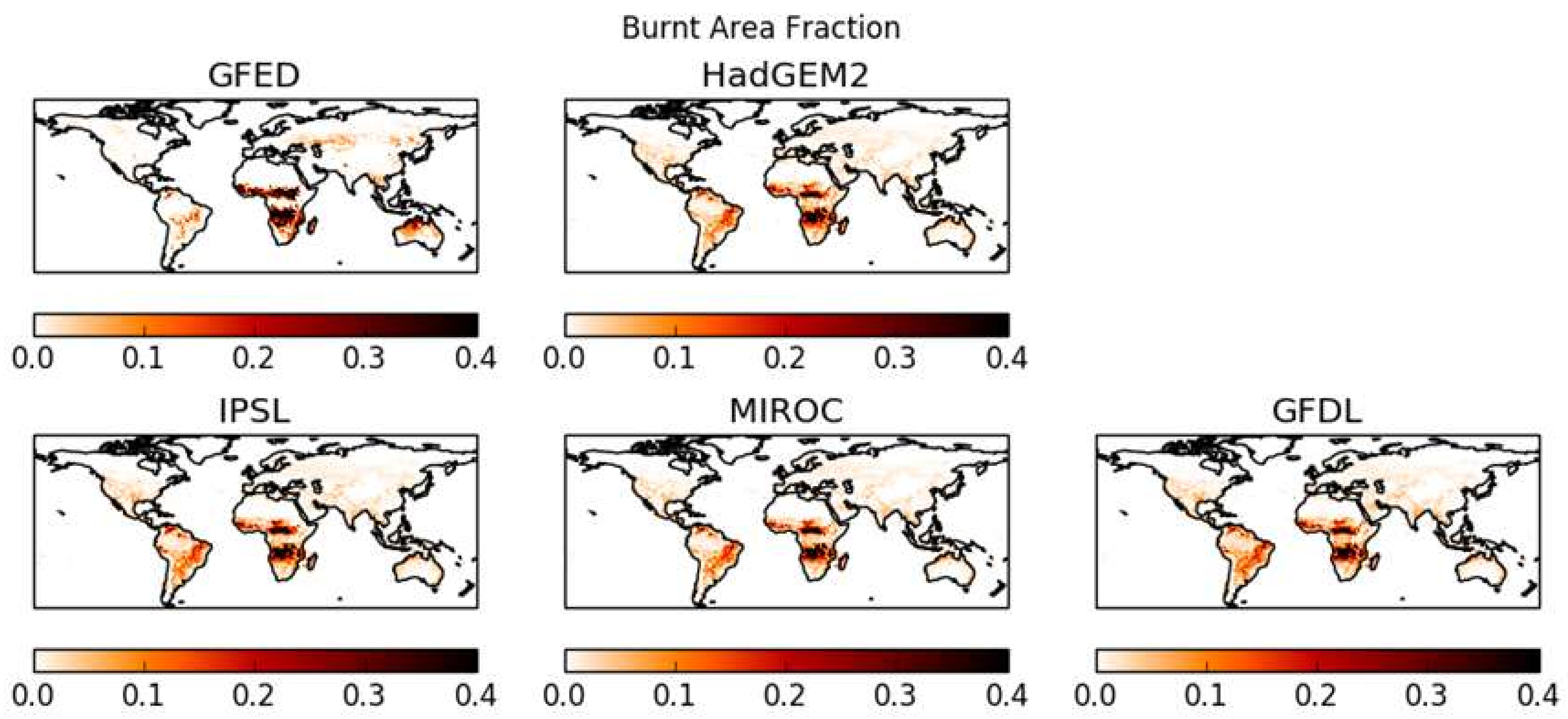
(veg mortality impact in dev.)

Likelihood of future impact

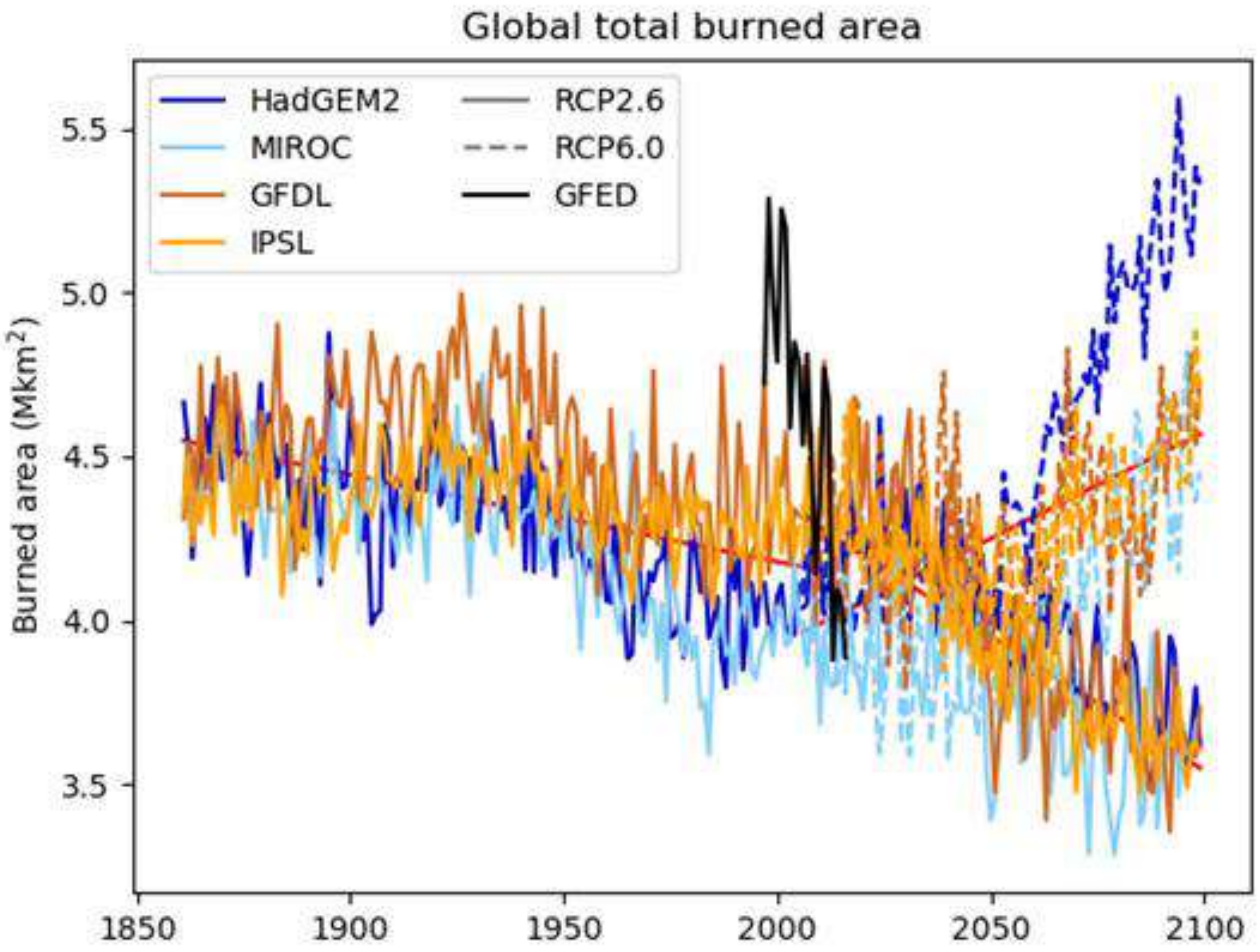
- Instead of projecting one future, calculate the likelihood of all possible futures

- Useful for very any impacts with high uncertainty? (not just fire)

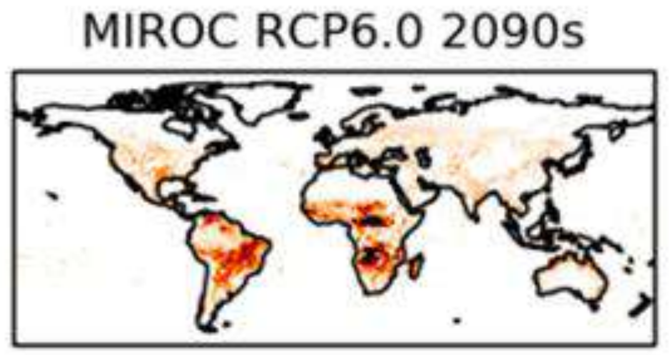
Problem 3: Uncertain future emissions and climate response



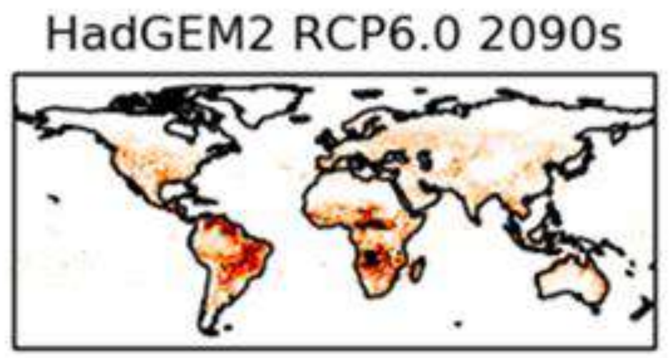
Burnt Area Fraction
GFED
HadGEM2
IPSL
MIROC
GFDL
0.0 0.1 0.2 0.3 0.4



Global total burned area
HadGEM2
MIROC
GFDL
IPSL
RCP2.6
RCP6.0
GFED
Burned area (Mkm^2)
5.5
5.0
4.5
4.0
3.5
1850
1900
1950
2000
2050
2100



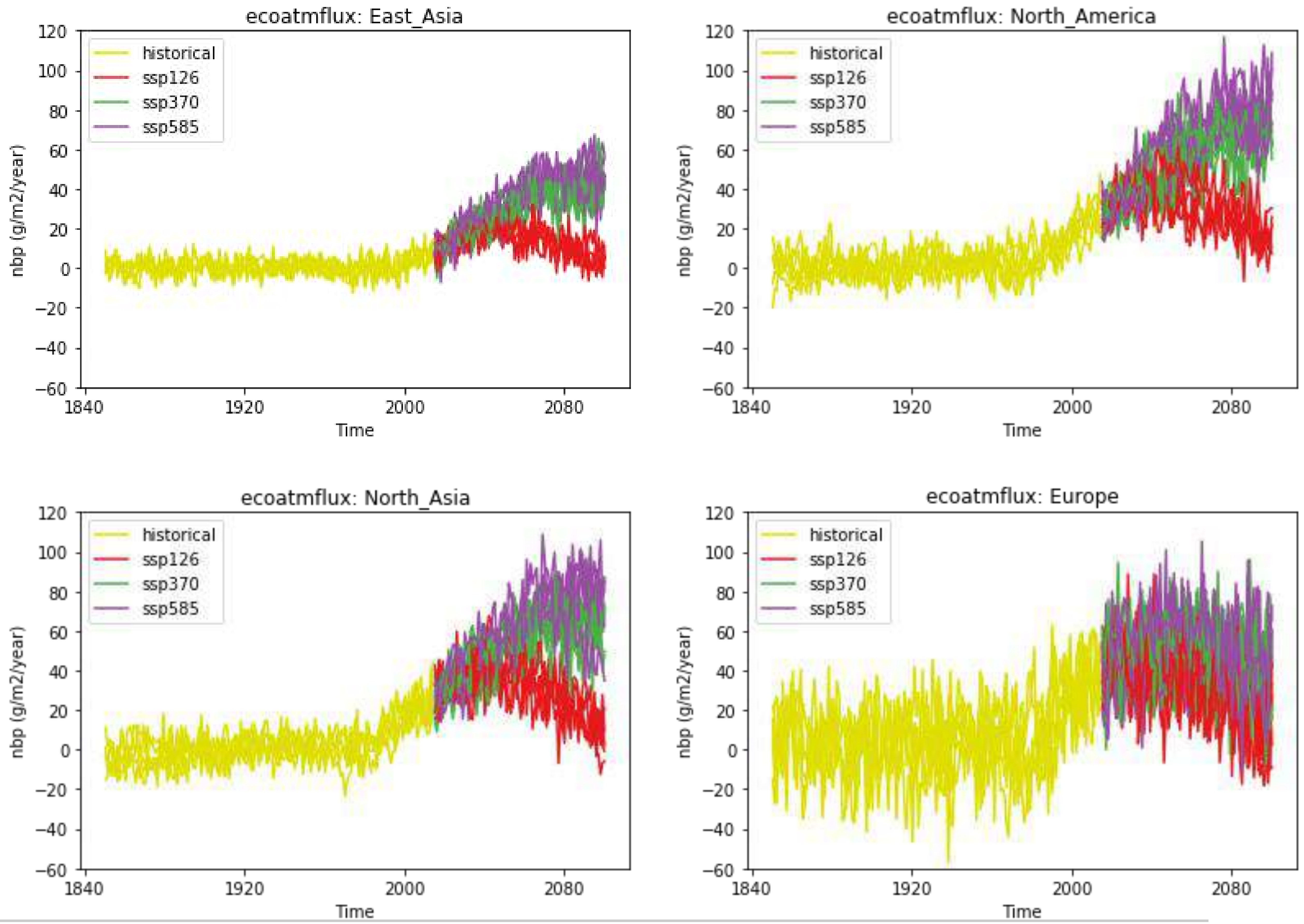
MIROC RCP6.0 2090s



HadGEM2 RCP6.0 2090s

JULES-ISIMIP

- Driven by multiple bias corrected models
- Over 3 different emissions scenarios
- Ongoing dev. for data assimilation
- Seems to perform better than TRENDY



JULES carbon(ish) capability for NC I stuff

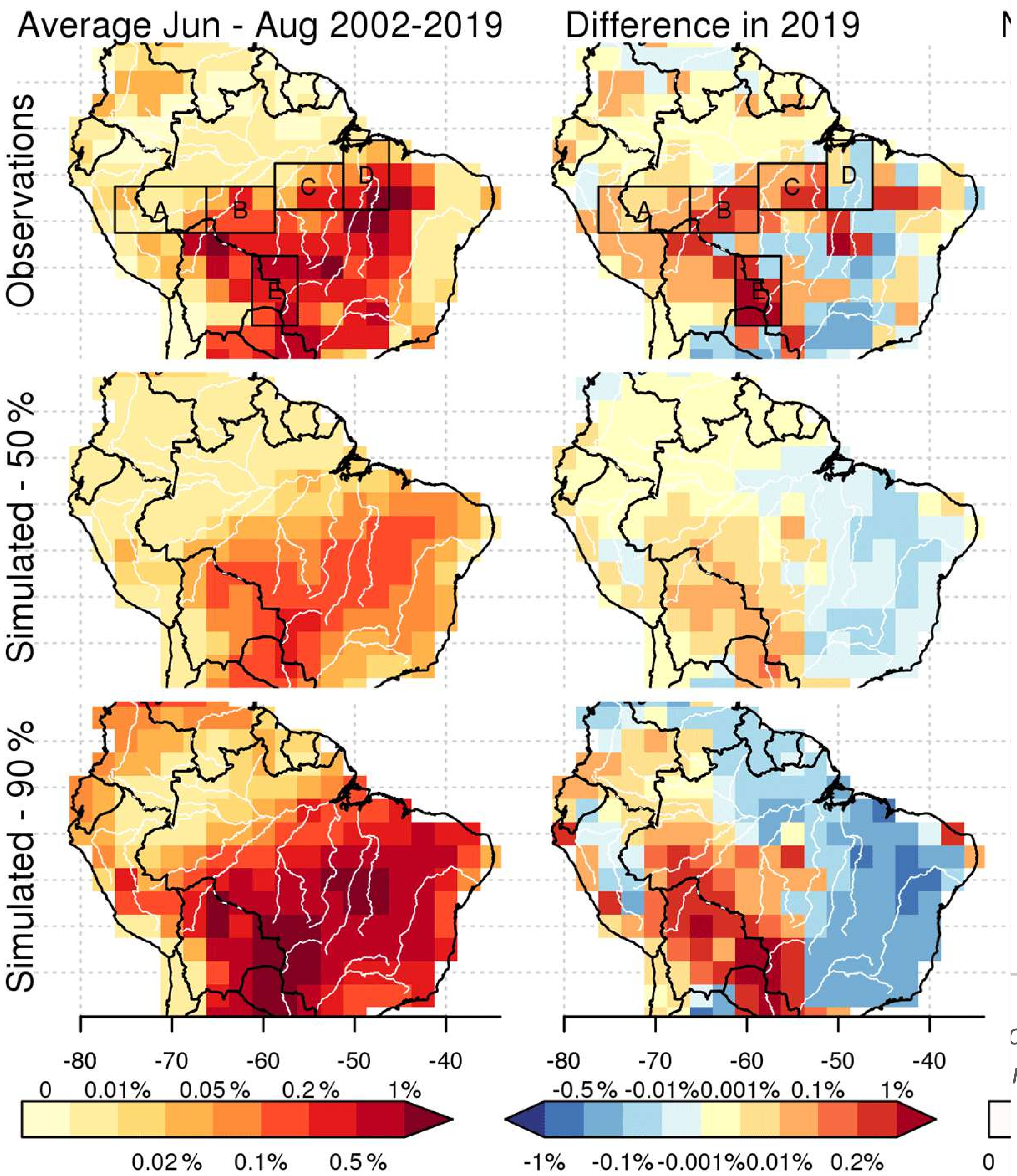
UKESM, TRENDY, ISIMIP and ConFire teams…

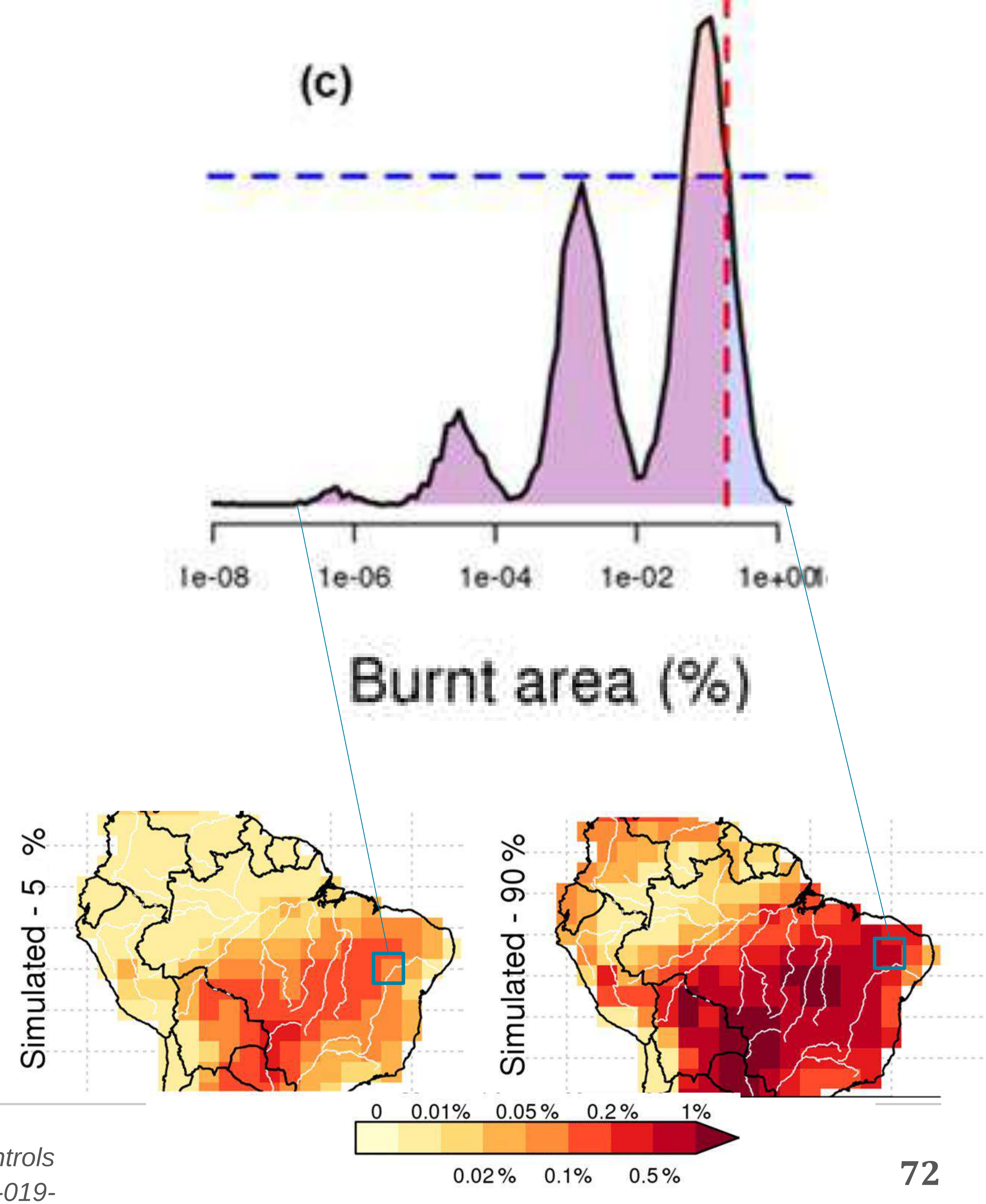
Douglas Kelley (UKCEH) Chantelle Burton (UKMO) Chris Huntingford (UKCEH) Rhys Whitley (Suncorp) Megan Brown (OU) Dong Ning (Imperial) Joshua Chew (U. of Sydney) Rob Parker (NCEO) Tiina Kurvits (GRID) Elaine Baker (GRID) Ioannis Bistinas (Cognizant Benelux) Toby Marthews (UKCEH) Camilla Mathison (UKMO) Andrew Sullivan (CSIRO) Gabriel Labbate (UNEP)

UK Centre for Ecology & Hydrology

Attributing drivers

Varying meteorology only





oclimatic and human controls
ng. doi:10.1038/s41558-019-0540-7

REDD+ finance buffer against fires

- Countries are paid to reduce forest carbon emissions.
- If a disturbance causes a loss which is not the fault of the country, RED++ holds some of the finance in a “Buffer” - a bit like insurance
- Fire is tricky cos it could be meteorological or direct human management

2019 fires in the Amazon rainforest by ESAs Luca Parmitano on the ISS

Slash and burn agriculture in the Amazon, Matt Zimmerman

What REDD+ needs to know

1. How much carbon is likely to be lost to fire (how much money should be held in the "buffer")
2. **If a fire does result in carbon loss, were they caused by people of weather?**
3. Can we determine where forest are vulnerable to future changes in fire?

REDD+ finance buffer against fires

REDD+ COP framework includes results-based payments (RBPs) to reward countries for reducing forest carbon emissions based on tonnes of CO2e emissions avoided.

“Buffer” system whereby a % of financing is held back for “insurance” against carbon loss from disturbances from fire.

Fire is tricky cos it could be from natural, climate change or direct human management